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3. Electrical
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5. Fire Protection
6. Commissioning
7. Appendix
1. Introduction
STANDARD REVIEW MATRIX
EXISTING STANDARDS REVIEW MATRIX

1. INTRODUCTION

These standards were developed for New York Presbyterian Hospital (NYPH) and will be used to develop the MEP design on all new and renovation projects. The selection of the engineer was done through a competitive bid process. Through that effort, AKF was selected based upon their national work experience in healthcare and familiarity with the NYPH campuses.

AKF met with all required members of NYP staff at CUMC and WCMC campuses to establish a basis of equipment design, which will standardize all HVAC, Electrical, Plumbing, Fire Sprinkler Protection, Fire Alarm system equipment/manufacturers and related materials to be utilized for this healthcare facility. (Sign Off Sheet Attached)

The basis of work was the previous NYPH standards from Feb. 2000 and April 2012. AKF reviewed, updated and provided recommendations for development of the updated standards presented in CSI format specification.

Written standards with pertinent information were reviewed by New York Presbyterian Facilities and requested changed made by the consultant. AKF has provided cut sheets for all major equipment, and as requested for specialty systems.

The Guidelines are available to consultants and NYP staff through the internet site,

https://enet.nyp.org/sites/facilities

These standards are intended to be a living document that allows New York Presbyterian to maintain consistent MEP/FP design and equipment installation in their healthcare facilities. The guidelines will be evaluated on a periodic basis by the NYPH staff and will be revised as required.

END OF SECTION
NYP 2015 STANDARDS SIGN OFF
WEIL CORNELL CAMPUS PLUMBING STANDARDS

These standards were developed for New York Presbyterian Hospital (NYPH) and will be used to develop the MEP design on all new and renovation projects. The purpose of this document is to provide the design engineer with guidelines for HVAC, electrical, plumbing, fire protections, fire alarm systems, nurse call, commissioning and controls equipment specified herein on NYPH campuses. This does not substitute the design engineer’s specification for each job but provides the basis and standards, which the design engineer shall follow. The final responsibility for the design of a specific project is the design engineers.

These standards serve as general guidelines and apply to both the design and construction phases of any project. Any deviation from these standards must be discussed with NYPH (Engineering Staff) Office of Facilities Operation (FO).

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<th>NAME</th>
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<tr>
<td>Patrick Ford</td>
<td>paf502@nymhs</td>
<td>212-4223</td>
<td>F/O</td>
</tr>
<tr>
<td>Brian Reilly</td>
<td>bjg002@nymhs</td>
<td>212-1944</td>
<td>F/O</td>
</tr>
<tr>
<td>Joe Kerns</td>
<td>jok505@nymhs</td>
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NYP 2015 STANDARDS SIGN OFF
COLUMBIA CAMPUS – PLUMBING STANDARDS

These standards were developed for New York Presbyterian Hospital (NYPH) and will be used to develop the MEP design on all new and renovation projects. The purpose of this document is to provide the design engineer with guidelines for HVAC, electrical, plumbing, fire protections, fire alarm systems, nurse call, commissioning and controls equipment specified herein on NYPH campuses. This does not substitute the design engineer’s specification for each job but provides the basis and standards, which the design engineer shall follow. The final responsibility for the design of a specific project is the design engineers.

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NYP 2015 STANDARDS SIGN OFF
COLUMBIA CAMPUS

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<th>NAME</th>
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<tbody>
<tr>
<td>Matt Allen</td>
<td><a href="mailto:matt.m@nyp.org">matt.m@nyp.org</a></td>
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<tr>
<td>Michael Bauer</td>
<td>david bible</td>
<td>317-767-2112</td>
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<td>Tommy Moreau</td>
<td><a href="mailto:malcolm1075@nyp.org">malcolm1075@nyp.org</a></td>
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<td>Joseph Castellano</td>
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<tr>
<td>Mark Kleen</td>
<td><a href="mailto:mark.2014@nyp.org">mark.2014@nyp.org</a></td>
<td>305-394-2764</td>
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<tr>
<td>Edgardo Salazar</td>
<td><a href="mailto:edgardo@nyp.org">edgardo@nyp.org</a></td>
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<tr>
<td>Terence Bruno</td>
<td><a href="mailto:terence@nyp.org">terence@nyp.org</a></td>
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Signature: ____________________________
Terence Bruno
2/10/2015

10 February 2015
New York Presbyterian Hospital Engineering Design Standards Review
HVAC (Revised 03/15/2014)
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<tr>
<th>Specification Section</th>
<th>CSI Specifications</th>
<th>NYPH Specification Title</th>
<th>Equipment Name</th>
<th>NYPH Listed Manufacturers</th>
<th>Additional Manufacturers Recommendation</th>
<th>NYPH Spec Item/Component</th>
<th>AKF Recommendation</th>
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<td>Outdoor design conditions 92 deg.F db/74 deg.F wb (1% design)</td>
<td>Use 95 deg.F db/77 deg.F wb (0.4% design)</td>
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<td>Filter Efficiency as per Table 3</td>
<td>Use ASHRAE 170-2008 Std.</td>
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Basis of Design
- Clean Steam Generators

NYPH Comment:
All isolation room pressure monitors and tracking pairs shall be monitored by the BMS.

Butterfly valves are unacceptable for steam use only. Acceptable in other instances pending review.

Include Clean Steam guidelines section for humidification and sterilization indicating compliance with ASHRAE 62.1 & 170, international healthcare standards HTM.
### New York Presbyterian Hospital Engineering Design Standards Review – HVAC (Revised 03.15.2014)

<table>
<thead>
<tr>
<th>Specification Section</th>
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<tr>
<td>Basis of Design</td>
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<td>2010, HTM 2031, and EN 285. Clean steam generator supplied with a water softener, constructed from stainless steel</td>
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<td>Basis of Design</td>
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<td></td>
<td>Add fan wall VFD configuration recommendation and application requirements for air handling systems. Bifurcated unit requires one VFD per bank, if one VFD fails the other will pick up. Isolation switches between the distribution block and drive to keep units running.</td>
<td></td>
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<td>X</td>
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<td>Add VAV zoning recommendations</td>
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<td>Pressure Monitors</td>
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<td>Include updated room</td>
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### New York Presbyterian Hospital Engineering Design Standards Review – HVAC (Revised 03.15.2014)

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<td>pressurization and differential pressure requirements for Isolation and Operating rooms.</td>
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<td>UV light &amp; humidistat monitoring added to BMS.</td>
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<td>Motor requirements clarified.</td>
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<td>Any motor that will be installed in an AHU that might see any type of moisture should be ODP to prevent any moisture entering the windings and shorting out the motor</td>
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<td>General Provisions</td>
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<td>Products</td>
<td>Add shaft gratings, trench covers &amp; frames, guard railings and valve charts Access requirements for above ceiling equipment clarified.</td>
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<td>Safety Relief Valves</td>
<td>Consolidated, Kunkle, Lonergan</td>
<td>Leslie, Sarco</td>
<td>High Pressure Steam Piping</td>
<td>Add stress analysis by a licensed engineer requirement</td>
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<td>Hot Water/Chilled Water/Condenser Water Systems</td>
<td>Gate, Globe &amp; check valves</td>
<td>Crane, Milwaukee, Stockham</td>
<td>Nibco</td>
<td>Copper Piping</td>
<td>Allow for chilled and Hot Water piping up to 4”. Use type ‘K’ with brazed joints.</td>
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<td>Copper Piping</td>
<td>Allow for chilled and Hot Water piping up to 4”. Use type ‘K’ with brazed joints.</td>
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**Recommendation:**
- Only forged valves for steam applications noted in schedule
- New Section
- Silent check
<table>
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<tr>
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<td>Lubricated Plug Valves</td>
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</table>

NYPH Comments: Butterfly Valves are not acceptable at NYPH-WCMC from the building standards.

| 15560 | 238219 | Fan-coil Systems | Fan-coil Units | - | - | Motor | Use ECM type motor for low noise and energy | X | X |     |     |     |

- 8 -
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<td>Easco, Lochinvar, Raypak</td>
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<td>Include Boiler Trim, draft control &amp; smoke alarm, BMS interface</td>
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Piping
Use factory supplied hydronic piping & valves package
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- Refrigeration Plant Chiller: Carrier, Dunham Bush, York
- Additional Manufacturers Recommendation: McQuay with magnetic bearings and dual compressors
- Refrigerants: Use R-123 or R-134a
- Trane: Acceptable at NYPH
- MER Space: Separate from boiler room
- Controls: Include BMS Interface and chiller plant optimization software
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<td>15590</td>
<td>238123</td>
<td>Computer Type Air conditioning</td>
<td>Computer Room Air conditioners</td>
<td>Air Flow, Data Air, Liebert: Basis of Design</td>
<td>Stulz-ATC</td>
<td>Accessories</td>
<td>Include waterside economizer for free cooling</td>
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<tr>
<td></td>
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<td>Basis of Design</td>
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<td>Per NYPH, Liebert shall be the basis of design for computer room units. A deviation from this manufacturer requires FO approval.</td>
<td>X</td>
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<td></td>
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<td>Controls</td>
<td></td>
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<td>Coordinate final controls with NYPH. FO to approve use of manufacturer’s controls or Siemens.</td>
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<td>Kitchen exhaust ducts</td>
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<td>10 gauge black steel construction</td>
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<td>Motors</td>
<td>HVAC Motors</td>
<td>General Electric, Gould, Louis Allis, Reliance</td>
<td>Baldor</td>
<td>Single Phase Motors less than ¾ HP</td>
<td>Use ECM variable speed motors for energy saving and ease in balancing NYPH Comments: Motors shall have minimum 95% efficiency. Inverter duty motors required as standard. Solid state motor</td>
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<td>15660</td>
<td>230514 230515</td>
<td>Motor Controllers</td>
<td>Motor Controller s</td>
<td>ABB, Cutler Hammer, General Electric, Square D</td>
<td>Controler with overload protection to be used for small motors. Large motor installation/rigging requirements added.</td>
<td>Upgrade to VFD's</td>
<td>Use smart starters with external control and monitoring capability. Lower installed cost.</td>
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<td>NYPH Comment: Cutler Hammer shall be removed from the building standards.</td>
<td>VFD’s</td>
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<td>Water Treatment Sand Filters</td>
<td>Knight Filters, Comeraiad Filters, Neptune Co, Yardley Corp.</td>
<td>Ameriwater High efficiency sand filters provide 0.5 micron filtration.</td>
<td>Provide 10 micron sand filters @ CU campus</td>
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<td>Thermometers Gauges&amp; Recording Instruments</td>
<td>Pressure Gauges</td>
<td>Ashcroft, Dresser Ind., Weiss, Weksler</td>
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<td>Add Ultrasonic Flow &amp; Energy Meters</td>
<td>Use Controlotron, Contrec, Parametric flow meters</td>
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<td>Balancing Air &amp; Water System</td>
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<td>Add approved test &amp; balance companies with healthcare experience</td>
<td>ITB, Merendino Associates, Thermal Thinkers, Dome Tech, Noresco</td>
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<td>Preferred Utilities Corp., Webster</td>
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<td>Leak Detection</td>
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<td>Leak Detection</td>
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### New York Presbyterian Hospital Engineering Design Standards Review – HVAC (Revised 03.15.2014)

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<td></td>
<td>To Facilities Office for approval CUMC: Leak detection for underground storage shall be similar to Milstein Fuel Oil project Phase 1&amp;2, coordinate with Facilities Office.</td>
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<td>Room Fire Rating</td>
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<td>15730</td>
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<td>Building Automation &amp; Control Systems</td>
<td>HVAC Control System</td>
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<td>Siemens Only, Automated Logic is acceptable at WCMC</td>
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<td>Airflow Stations</td>
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<td>Filters</td>
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<td>T'stats</td>
<td>NYPH Comment: Common areas shall be provided with temperature sensor with no display or adjustment features.</td>
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<td>T'stats</td>
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<td>Sequences</td>
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<td>Bacharach</td>
<td>NYPH Comment: MSA ChillGuard IR is not acceptable,</td>
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<td>Fuel Tank Storage (NYC BC 2014)</td>
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<td>Underground Fuel Storage shall be anchored and design and installed to prevent flotation, collapse, and lateral movement from hydrostatic</td>
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forces. Additional capacity and storage location requirements per NYC BC G307 and G310.6 and G304.
<table>
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<tr>
<th>NYPH Spec Section</th>
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Comments: Use steel set-screw fittings or unicouple connectors for EMT conduits. Compression fittings on a per design basis with FO approval. NYPH Comments: All emergency branch circuits are to be run in conduit. Normal branch circuits are permitted to be run in hospital grade type HCF-90 cable with F.O. approval only.
<table>
<thead>
<tr>
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<td>16020</td>
<td>260513 260519 260533</td>
<td>Wire and Cable</td>
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<td>Comments: Use arc-proof wrapping around each feeder 100A and above in common pull boxes where two or more feeders are run thru same box at CUMC.</td>
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All branch circuits shall be run with dedicated neutral conductors. Shared neutrals and multi-pole (common trip) circuit breakers for independent loads shall not be permitted.
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NYPH Comments:
For isolation power systems (example Operating Rooms) branch circuits shall utilize type XHHW conductor insulation. THHN/THWN shall not be permitted for this application.

NYPH Comments: All boiler plant wiring for branch circuits and controls shall be high temperature rated.

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<td>16200</td>
<td>263213</td>
<td>Diesel Engine Driven Standby Power Plant</td>
<td>Diesel generators</td>
<td>Onan-Cummins, Detroit Diesel, Caterpillar</td>
<td>Per NYPH Comments, Caterpillar is basis of design. Onan-Cummins, Detroit Diesel are acceptable manufacturers. For Load bank: Avtron Simplex, Inc</td>
<td>Load bank Outdoor generator set enclosure</td>
<td>On-site load bank Soundproof outdoor enclosure NYPH Comment: The requirement for radiator mounted load banks or stand alone is on a per project basis to be approved by NYPH.</td>
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<td>Generator Synchronizing Switchboard</td>
<td>Control panel</td>
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<td>NYPH Comment: ASCO only. Electronic control</td>
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<tr>
<td>16400</td>
<td>261116 261200 261300 262200</td>
<td>Unit Substation Indoor and outdoor units</td>
<td>- Siemens - Square D - ABB Controls - Cooper Industries - Cutler-Hammer - Olsun</td>
<td>N/A</td>
<td>N/A</td>
<td>NYPH Comment: GE not an approved manufacturer at CUMC.</td>
<td>X</td>
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<tr>
<td>16410</td>
<td>262300</td>
<td>Low Voltage Distribution Equipment</td>
<td>Low voltage switchgear</td>
<td>All-City, Atlas, Lincoln Electric</td>
<td></td>
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<td>X</td>
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<td>263600</td>
<td>262816</td>
<td>262913</td>
<td>262413</td>
<td>262416</td>
<td>262419</td>
<td>262600</td>
<td>262713</td>
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<td>AKF Comment: Powercom not approved manufacturer.</td>
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<td></td>
<td>NYPH Comments: All main and tie switches 1200A and above shall be high pressure contact (HPC) type. Removed bolted pressure (BPS) switch type. Requirement for high pressure contact (HPC) at WCMC is 800A and above.</td>
<td>X</td>
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<td></td>
<td></td>
<td>NYPH Comments: All CUMC switchboards and panelboards shall be manufactured by</td>
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<td>262213</td>
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<td></td>
<td>All-City, Atlas, or Lincoln Electric. Switchboard manufacturers shall use only Siemens components. Only non-national branded equipment is acceptable. Same requirement for WCMC for 800A and above.</td>
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<tr>
<td>262813</td>
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<td></td>
<td>NYPH Comments: Switchboards shall be bolted to concrete pads or welded to concrete pad steel structural elements. High tension equipment shall be mounted to steel rails in pad.</td>
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<th>AKF Recommendation</th>
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<tr>
<td>Automatic Transfer Switch (ATS)</td>
<td>ASCO</td>
<td>Per NYPH, ASCO only.</td>
<td></td>
<td></td>
<td>NYPH</td>
<td>Comments: All ATS shall be 4-pole, overlapping neutral, isolation by-pass type and shall have accessory 30B – load shed, 72E – serial communicator, and 23B – power monitor. Provide remote annunciators.</td>
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<td>(ATS)</td>
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<td>WCMC: Any ATS 400A and</td>
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**Comments**:
- Fail safe GFCI circuit breakers shall be used in lieu of GFCI receptacle devices at CUMC. GFCI receptacles are permitted at WCMC.
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<td>above shall have a bypass.</td>
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<td>Fuses</td>
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<td>NYPH Comments: All fuses shall be Bussman yellow low-peak type.</td>
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<tr>
<td>HPC-High Pressure Contact</td>
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<td>NYPH Comments: All main and tie switches 1200A and above shall be high pressure contact (HPC) type. Removed bolted pressure (BPS) switch type. Requirement for high pressure contact (HPC) at WCMC is 800A and above.</td>
<td>X</td>
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<td>Low-Voltage Transformer s</td>
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<td></td>
<td>NYPH Comments: All transformers 150kVA and below shall be Hazard Location</td>
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The table outlines the electrical specifications and recommendations for various components in the New York Presbyterian Hospital, focusing on specific manufacturers and their recommendations.
<table>
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<tbody>
<tr>
<td>16420</td>
<td>262500</td>
<td>Busways</td>
<td>Location Encapsulated Distribution Transformer</td>
<td>- Siemens</td>
<td>Basis of Design</td>
<td></td>
<td>Encapsulated type, NEMA 3R. Core &amp; coil shall be encapsulated within resin compound sealing out moisture and air.</td>
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<td>- Square D</td>
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<tr>
<td>16430</td>
<td>260523</td>
<td>Power, Control and Alarm Wiring Systems</td>
<td>Basis of Design</td>
<td>- Siemens</td>
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<td>- Cutler-Hammer</td>
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<td>16440</td>
<td>260526</td>
<td>Grounding system</td>
<td>Basis of Design</td>
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<td>16450</td>
<td>262726 260553</td>
<td>Devices</td>
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<td>NYPH Comments: WCMC: Hubbell hospital</td>
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- 10 -
<table>
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<td>Other acceptable manufacturers (when manufactured to “Hubbell Standard”):</td>
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<td>- Leviton</td>
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<td>- Pass &amp; Seymour</td>
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<td>Grade Only, Hubbell standard not acceptable. Any tamper resistant outlet shall be Hubbell Hospital Grade</td>
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<td>NYPH Comments: GFCI circuit breakers shall be used in lieu of GFCI receptacle devices at CUMC.</td>
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<td>NYPH Comments: Emergency receptacles shall be backlit illuminated type at CUMC only.</td>
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<td>NYPH Comments: Receptacle color coding shall be: Normal: White</td>
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<td>or per Architectural design. Emergency: Red (and back-lit at CUMC only.)</td>
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<td>NYPH Comments: Receptacles shall be tamper resistant integral shutter-type in all public waiting areas and pediatric areas, including ICUs. O.R.’s are exempt.</td>
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<td>NYPH Comments: Headwall device emergency circuits shall not be shared between headwalls. Normal circuits are permitted to be shared within permissible load constraint.</td>
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<tr>
<td>16470</td>
<td>N/A</td>
<td>Pipe Heat Tracing System</td>
<td>-</td>
<td>-</td>
<td>Raychem</td>
<td>-</td>
<td>NYPH Comments: Raychem Self-Regulating Armor Covered Connect to BMS were applicable and approved by NYPH.</td>
<td>X</td>
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<td>16500</td>
<td>260923 265100 265200</td>
<td>Lighting Fixtures</td>
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<td>NYPH Comments: Refer to NYPH Interior Guidelines. All light fixtures shall be chain supported regardless of weight.</td>
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<td>Fire Alarm System</td>
<td>Vendor NYP CUMC:TSS NYP-WC:ISPI or Honeywell</td>
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<td>NYPH Comment: Include vendor contact information in</td>
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<tr>
<td>283111</td>
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<td>Fire Alarm System (CUMC)</td>
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<td>Fire alarm ATS to be red in color at CU</td>
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<td>Per NYPH, ABB only</td>
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<td>New Section: Variable Frequency Motor Controllers</td>
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<td>- Liebert N and NX Series</td>
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<td>(2 Strings of Batteries and min. reserve time)</td>
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New Section: Static Uninterruptible Power Supply
NYPH Comment: MGE, Powerware are approved manufacturers.

New Section: Power Factor Correction Equipment
X   X

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### New York Presbyterian Hospital Engineering Design Standards Review – ELECTRICAL (Revised 03.15.2015)

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**Basis of Design**

All main service disconnecting means and circuit breakers shall be located above and accessible from above the design flood elevation per NYC BC G501.1 and G310.6 and G304.
New York Presbyterian Hospital Engineering Design Standard Review
PLUMBING (Revised 03.15.2015)
### New York Presbyterian Hospital Engineering Design Standard Review - PLUMBING (Revised 03.15.2015)

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1. INTRODUCTION

These standards were developed for New York Presbyterian Hospital (NYPH) and will be used to develop the MEP design on all new and renovation projects.

The purpose of this document is to provide the design engineer with guidelines for HVAC, electrical, plumbing, fire protections, fire alarm systems, nurse call, commissioning and controls equipment specified herein on NYPH campuses. This does not substitute the design engineers specification for each job but provides the basis and standards, which the design engineer shall follow. The final responsibility for the design of a specific project is the design engineers.

These standards serve as general guidelines and apply to both the design and construction phases of any project. Any deviation from these standards must be discussed with NYPH (Engineering Staff) Office of Facilities Operation (FO).
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<td>Standpipe Risers, Sprinkler valve assembly control valves and cross connections must be painted as per Local Law 58/09</td>
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<td>Pressure Regulating Valves</td>
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GENERAL
1. INTRODUCTION

A. These standards were developed for New York Presbyterian Hospital (NYPH) and will be used to develop the MEP design on all new and renovation projects.

The purpose of this document is to provide the design engineer with guidelines for HVAC, electrical, plumbing, fire Protections, fire alarm systems, nurse call, commissioning and controls equipment specified herein on NYPH campuses. This does not substitute the design engineer’s specification for each job but provides the basis and standards, which the design engineer shall follow. The final responsibility for the design of a specific project is the design engineer’s.

These standards serve as general guidelines and apply to both the design and construction phases of any project. Any deviation from these standards must be discussed with NYPH (Engineering Staff) Office of Facilities Operation (OFO).

2. ASBESTOS

Prior to starting any project, the asbestos impact and scope of abatement work must be reviewed with NYPH OFO.

Once the scope of work has been determined, the Engineer will provide NYPH Project Manager with drawings indicating the areas impacted by the construction work.

3. DESIGN PHASE

The New York Presbyterian Design Standards shall be used by architectural design and engineering consultants, contractors, and hospital staff involved in the design, new construction, and renovation of NYPH facilities. The NYP Design Standards provides both general guidelines as well as detailed specifications for the design and selection of MEP/FP systems and equipment.

Prior to the start of any project, meetings shall be scheduled by the NYPH PM with the Architect and Engineer to discuss the scope of work and establish document submission schedules.

All projects are to be established with identifiable goals and requirements (Basis of Design). The requirements are to be published and distributed to team members at the start of the project and are to be updated at measureable milestones throughout the project life. These
milestones consist of phases identified as programming phase, schematic design phase, design development phase, construction document phase, construction and commissioning.

Once the scope of the project is determined, the engineer shall begin the design process. To ensure that all NYPH projects follow the same standards, an Engineering Check List has been developed and must be used while developing all phases of the project design documents (SEE APPENDIX).

Drawings shall be prepared on CAD using AutoCAD Release 14 or higher. The Architect develops the format of the floor plans and issues to the Engineer to be used in developing the design documents. All drawings shall be a minimum of 1/8” scale with special details and MER’s at a minimum of ¼” scale. (SEE CAD STANDARDS IN APPENDIX).

A. Schematic Phase (SD):

A schematic document shall be prepared to establish the MEP scope of work and project budgets.

The information provided during this phase shall include as a minimum:

1) A written description of the MEP/FP systems.

2) An estimate of the required MEP/FP system capacities including chilled water, steam, hot water (heating and reheat), electrical (normal and emergency), medical gases, hot and cold water and other major infrastructure utilities.

a) The estimated load requirements shall be issued to and reviewed by NYPH PM, OFD, and OFO.

b) The design engineer and NYPH-OFO shall fill out a;  

1) Building Utility Request Checklist.

c) NYPH-OFO shall advise if the existing infrastructure can accommodate the requested load required for any partial floor renovation.

d) A meeting shall be scheduled by the NYPH PM with the Engineer, NYPH-OFO and OFD to review any existing infrastructure limitations and to determine what infrastructure upgrades are required to accommodate the proposed renovation.
e) If infrastructure upgrades/improvements are required to accommodate a proposed partial floor renovation NYPH-OFO will coordinate the individual project requirements with any future capital improvement and or maintenance projects.

f) The NYPH PM, OFO and OFD shall coordinate and determine the source of the additional capital required to provide any infrastructure upgrades.

g) The design engineer and/or architect shall coordinate submission of any required additional services due to infrastructure upgrades not included in the base contract with the NYPH PM, OFO and/or OFD.

3) Points of tie-in to the existing services. This shall be reviewed and approved by NYPH – OFO staff.

4) Sketches indicating block layouts of major equipment and system components and distribution of main piping, conduits and ductwork.

The schematic documentation shall be issued to NYPH PM, OFD, and OFO staff for review and approval. Meetings shall be scheduled by the NYPH PM with the Engineer to review this package to ensure the program requirements have been incorporated into the MEP scope of work. A sign-off of this documentation by NYPH, OFO, and OFD staff is required prior to starting the Design Development Phase.

B. Design Development Phase (DD):

The information provided during this phase shall include as a minimum:

1) Design criteria including applicable codes and standards.

2) Updated MEP/FP system descriptions and system capacities.

3) Location of all major equipment and system components including physical requirements, clearances, access, etc.

4) Riser diagrams of all systems.

5) Flow diagrams.

6) Electrical single line diagrams.
7) MER layouts.

8) Floor plans indicating complete system design concepts including main distribution, controls zones, fire alarm and sprinkler zones, points of connection to existing systems and/or risers, electrical closet locations, shaft locations (piping/ductwork), etc.

The Engineer must perform a thorough field investigation of all existing utilities. Available existing drawings shall be used for general information. Engineer should request the latest drawings from NYPH PM. Using the existing drawing information, the Engineer will develop sketches indicating the area requiring access, i.e., ceilings, walls, etc. to verify the existing piping, ductwork, conduits, etc. The NYPH PM will arrange for the area as noted to be opened and schedule a walk-through to confirm existing MEP services.

Meetings must be scheduled with NYPH OFO staff to discuss existing system impacts, confirm existing system capacities, availabilities, points of connection to existing systems, etc.

NYPH OFO staff should always be advised of engineering design issues or required changes while developing the design documents.

Meetings shall be scheduled by the NYPH PM between the Architect and the NYPH User groups to further develop the program requirements. Meetings are then scheduled between the Architect and Engineer to transfer this information via equipment cuts and/or marked up drawings so the MEP design requirements could be developed.

After the Architect’s program layouts have been approved by NYPH, the Architect and Engineer discuss/agree on the format of the deliverables, i.e., drawings and specifications.

Weekly meetings shall be scheduled by the Architect with the Engineer to ensure these program requirements are incorporated and coordinated into the MEP design documents as well as updating any information from the User groups given to the Architect.

Coordination meetings shall be scheduled by the Architect and/or OFD-PM among the design team, and OFO groups to ensure all program requirements are met and to discuss/review the impacts to the existing MEP systems and/or new systems required by design.
The design must be fully coordinated with all of the disciplines, such as Architectural, Structural, HVAC, Electrical, Plumbing, Fire Protection and Site Planning.

The Design Document documentation shall be issued to NYPH PM, OFD, and OFO staff for review and approval. Meetings shall be scheduled by the NYPH PM with the Engineer to discuss this package to ensure the program requirements have been incorporated into the MEP scope of work. A sign-off of this documentation by NYPH, OFD and OFO staff is required prior to starting the Construction Document Phase.

C. Construction Document Phase (CD):

During this phase, the Design Development Documents shall be developed to the construction documents level.

Drawing “issue dates” are established and agreed to by the design team and NYPH PM.

Project meetings shall be scheduled by the NYPH PM/Architect with the Engineer, OFD and OFO staff throughout the CD Phase to ensure the program requirements are met and coordinate all the existing and new MEP system requirements.

Specifications shall be prepared using the CSI format and shall be issued in book form (Review NYPH PM). On smaller projects, the specifications are noted on the construction documents. The specifications will note the project name and date of issue. The specification format shall be approved by the NYPH PM.

Prior to using the construction documents, MEP review meetings shall be scheduled by NYPH PM with NYPH OFO Engineering group to review/approve the MEP systems design. Subsequent to this meeting, the design team shall incorporate the review comments into the CD documents and issue the 100% CD documents on the schedule date.

4. CONSTRUCTION PHASE

Once the construction documents (CD) have been approved and signed-off by OFO, the documents are issued for bidding and construction. NYPH selects the general contractor and/or CM and the drawings may be issued for pricing. Depending on the size of the project, NYPH may request the Engineer to review the MEP budgets to confirm the project scope of work prior to issuing for bid.
During the bidding time, the construction documents shall be submitted to the New York City Building Department for approval. The expeditor is selected by NYPH PM. The Engineer shall provide stamped and signed drawings to the expeditor upon request (usually 3 sets of drawings). The HVAC, plumbing and fire protection drawings are submitted as one package. The electrical drawings indicating the fire alarm scope of work only are submitted as a separate package. The expeditor issues the appropriate Building Department forms to the Engineer, which shall be stamped, signed and returned to the expeditor.

Prior to the start of construction, NYPH OFD PM schedules a kick-off meeting to introduce the team, the General Contractor or CM, Architect and Engineer. Schedules, construction phase procedures, etc., shall be discussed and weekly or bi-weekly construction meetings shall be established.

Prior to the start of the MEP system installations, the Contractor shall submit shop drawings for each trade including equipment cuts, plan layouts, fixtures, devices, etc., as outlined in the contract specifications to the Engineer for review/approvals. The drawings shall be reviewed and comments noted and returned to the Contractors in an expeditious (agreed schedule) manner.

All systems (where required by specifications) must be pressure tested prior to closing ceilings and/or walls. These tests must be witnessed by NYPH staff. The Contractor prepares schedules and forms for OFO signatures. These test reports are issued to the Engineer for review and pending approval the Contractor issues to OFO for their records.

The Engineer shall perform periodic field observations to ensure the installation conforms with the design intent. The Engineer shall issue progress reports after each field observation. During this process at various stages of completion, a NYPH OFO staff will accompany the Engineer during the field observation walk-through to understand the system design installation and note any installation deficiencies. This process continues throughout the construction phase, including the issuing of the final punch list at the substantial completion of construction. The NYPH PM schedules a final walk-through with the Engineer and OFO staff to develop the punch list. The following items are issues/design installations which are of major concern to OFO and must be verified by the Engineer for all NYPH projects during the construction phase and final punch list preparation:

A. Electrical:

1) Verify that all panel covers are installed.
2) All panels, bus ducts and panelboard switches shall be labeled per NYPH standards. (SEE APPENDIX).

3) All panels shall be labeled where they are fed from.

4) Spare circuit breakers shall be placed in the “off” position.

5) Verify completion of demolition work: feeders pulled from circuits, panels removed, conduits cut back to slab.

B. Fire Protection:

1) Signage indicating location of sprinkler system control assembly and sprinkler test and drain valve if not located in stairwells or control rooms.

2) Pressure gauges before and after PRV assemblies. Relief valve downstream of PRV. Upsized drain piping and drain riser.

3) Valve tags identifying system, number and zone served.

4) Tag on sprinkler system control valve indicating basis of design and hydraulic calculation flow requirements.

5) Tags on water flow alarm and tamper alarm switch indicating type, number and zone.

C. Plumbing:

1) Shut-off valves on all horizontal piping connected to fixtures and risers.

2) Valve tags indicating system and number.

3) Valve accessibility.

4) All piping systems and devices labeled or color coded (medical gases).

5) Identification markers on ceiling to indicate location of valves above ceiling.

6) All equipment/devices requiring maintenance shall be labeled per NYPH standards (SEE APPENDIX).

7) Adequate maintenance space around pumps, heaters, tanks, etc., allowing access to all components, devices, valves, gauges, etc.
8) Heavy duty couplings have been used on no-hub piping (sanitary system only).
9) Adequate number of floor drains are provided in MER’s adjacent to equipment, pumps, heaters, etc.
10) Hose bibbs have been provided wherever floor drains are installed.

D. HVAC:
1) Adequate access is provided for all equipment, actuators, fire dampers, controls, valves and other accessories installed in the ceiling. Identification markers are provided in ceiling to indicate locations in ceiling.
2) Piping system are labeled.
3) All valves are tagged and labeled with system and number.
4) All equipment/devices requiring maintenance shall be labeled per NYPS standards (SEE APPENDIX).
5) Adequate maintenance space around AHU’s, pumps, fans, etc., in MER’s allowing access to all components, devices, valves, gauges, etc.
6) All high points in piping systems are provided with air relief valves.
7) Multiple belts are provided on all fan drives.

E. Fire Alarm:
1) Signage indicating which fire alarm system devices are operational or out of service, during renovation/upgrade projects.
2) All equipment/devices requiring maintenance shall be labeled per NYPH standards (SEE APPENDIX).
3) Removal or safeguarding existing fire alarm system circuits and devices.
4) Verify completion of demolition work: existing devices, circuits and fire alarm components removed.
5) Notify site Fire Safety Engineer; Fire Safety Director and Security Department prior to disabling ANY Fire Alarm device, circuit or panel.

6) All Fire Alarm junction box and terminal box covers are installed, painted red and labeled in white lettering (indicating function, circuit and area served).

7) Return fire alarm system to operational condition at the end of each workday, or provide a Fire Watch accordance with New York City Building/Fire Codes.

Prior to completing construction and OFO sign-off, the NYPH PM schedules with the OFO staff preliminary training sessions by the Contractor to demonstrate the operation of all major equipment and systems, areas served, control connections to BMS, etc.

Prior to NYPH “move-in”, most projects are inspected by DOH. Prior to this inspection, the NYPH PM shall direct the Contractor to submit to NYPH PM the following documentation:

8) All MEP punch lists with sub-contractors signatures adjacent to each item indicating completion and letter from GC/CM confirming same.

9) Test reports for all systems.

10) Letter stating that the HVAC system was balanced and reports if completed and approved by the Engineer.

11) All medical gas system certifications (if applicable).


13) Fire Department Inspection Report (fire alarm system).

F. Substitutions:

1) No substitute material or manufacturer of equipment shall be permitted without a formal written submittal to the engineer which includes all dimensional, performance and material specifications and is approved in writing by the engineer. Any changes in layout or design brought about by the use of a substitution shall be submitted to the engineer fully designed for review in conjunction with the submittal of the alternate. Any substitution must be submitted with an explanation why a substitution is being utilized. All additional costs (all trades) due to the substitution shall be covered by the
contractor. If the substitute is being utilized for financial reasons, the associated credit must be simultaneously submitted. Final acceptance or rejection of any substitution is subject to the NYPH OFO’s review.

G. Commissioning/Acceptance Phase:

The activities outlined in this section shall be managed/initialed by the NYPH-PM.

Prior to NYPH accepting any project the following documentation must be submitted by the GC and/or CM to NYPH PM for distribution:

1) Letter stating that all MEP and FP punch list items have been corrected. Letter to include all punch lists signed by sub-contractors indicating completion.

2) Test reports and all medical gas system certifications (if applicable).

3) As-builts drawings for all trades.

4) O&M Manuals for all trades including;
   a) Descriptive literature for equipment and components.
   b) Model number and performance data.
   c) Installation and operating instructions.
   d) Maintenance and repair instructions.
   e) Spare parts lists.
   f) Phone number and person’s name (if possible) of manufacturer.
   g) Number of manuals per NYPH request.

5) Balancing reports.
   a) Valve charts.

6) Equipment warranties.

7) Equipment training certifications (if applicable).

8) Equipment/devices label list (MSI Number) by NYPH standards.
9) Training/operational demonstration.

Prior to NYPH accepting any equipment, system, or major electrical switchboard rooms, emergency generator, closets, etc. a training and operational demonstration must be presented by the Contractor(s) who installed the equipment and/or system or by the manufacturer.

These demonstrations include:

a) All controls, alarms, connections to BMS for all HVAC units and equipment.

b) All fire alarm and sprinkler devices connecting to building fire alarm systems.

c) All alarms (main and local) from medical gas systems to central alarm panels.

d) All electrical component testing, transfer switches, emergency power, operations, etc.

10) Sign-off forms (final):

a) Sign-off forms [SEE APPENDIX] shall be used by the Engineer to assure installation of major electrical load centers and electrical closets.

END OF SECTION
HVAC – BASIS OF DESIGN
HVAC – BASIS OF DESIGN

1.1 DESIGN CRITERIA

A. The mechanical system shall be designed for overall efficiency and appropriate life-cycle cost. Details for cost-effective implementation are interrelated and too numerous (as well as too basic) to list individually.

1. Recognized engineering procedures shall be followed for the most economical and effective results. A well-designed system can generally achieve energy efficiency at minimal additional cost and simultaneously provide improved patient comfort.

2. In no case shall patient care or safety be sacrificed for energy conservation.

3. Use of recognized energy-saving mechanisms such as variable-air volume (VAV) systems, load shedding, programmed controls for non-occupied periods (nights and weekends, etc.), chilled beams and natural ventilation shall be considered, site and climatic conditions permitting.

4. Air handling system shall be designed with an economizer cycle where appropriate to use outside air. (Use of mechanically circulated outside air does not reduce the need for filtration)

5. The energy-saving potential of variable-air volume systems is recognized, and requirements herein are intended to maximize appropriate use of those systems. Any system used for occupied areas shall include provisions to avoid air stagnation in interior spaces where thermostat demands are met by temperatures of surrounding areas.

6. Unitary equipment that serves only one room shall be permitted for use as recirculation units only. All outdoor air shall be provided by a separate central air-handling system with proper filtration and noted in the FGI Guidelines. Equipment location shall be coordinated to minimize the need for maintenance within patient rooms.

7. Supply and return mains/risers for cooling, heating and steam systems shall be equipped with valves to isolate the various sections of each system.

8. Mechanical equipment, ductwork and piping shall be mounted on vibration isolators as required to prevent unacceptable structure-borne vibration.
9. Renovations: If system modifications affect greater than 10 percent of the system capacity, designers shall utilize pre-renovation water/air flow rate measurements in the affected zones to verify sufficient capacity is available and that renovations have not adversely affected flow rates in non-renovated areas.

10. Remodeling and work in existing spaces present special problems. As practicality and funding permit, existing insulation, ductwork, piping, equipment should be brought up to a standard for maximum economy and efficiency. Consideration should be given to additional work that may be needed to achieve this.

11. Acoustic Considerations:
   a. Outdoor mechanical equipment shall not produce sounds that exceed 65dBA at the hospital facade, unless special consideration is given to the facade sound isolation design in impinged areas.
   b. Outdoor mechanical equipment shall not produce sound that exceeds daytime and nighttime noise limits at neighboring properties as required by local ordinance.

B. All HVAC related design shall establish the necessary criteria for the design of the HVAC systems. This shall occur during the initial phase. The criteria shall include the following:
   1. Design indoor temperatures for summer and winter for each space.
   2. Design indoor humidity for summer and winter for each space.
   3. Outdoor air design temperatures for summer and winter.
   4. Minimum outdoor air requirements.
   5. Ventilation supply and exhaust requirements.
   6. Pressure relationship to adjacent areas.
   7. Maximum design occupant load for each space.
   8. Occupant use of spaces.
10. Lighting loads in space, type and use.

11. Hours of operation.

12. Flexibility, redundancy, spare capacity.

13. Outdoor design conditions for New York City:

<table>
<thead>
<tr>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>95°F, DB/77°F WB</td>
<td>5°F, DB</td>
</tr>
<tr>
<td>(Based on ASHRAE July 0.4% Occurrence)</td>
<td>(Based on mean of extreme low temperatures)</td>
</tr>
</tbody>
</table>

14. Heating degree days: 5000

15. Cooling tower selected for 78°F WB (ASHRAE 1% occurrence).

16. Special surgical areas identified by the users shall have the cooling capability to maintain 68°F (min.) and heating to maintain 75°F.


18. Air system filtration design conditions:

   a. All air handling systems shall incorporate air filtration media to the efficiencies indicated in the latest FGI Guidelines for Design and Construction of Health Care Facilities and Codes and Rules and Regulations of New York Title 10 Health Code.

   b. All filters shall be the “dry disposable type”.

   c. The efficiency of all filters shall be the average atmospheric dust spot efficiency based on ASHRAE Standard 52.1 – 1992 and MERV-A (Minimum Efficiency Reporting Value) efficiency according to standard 52.2-2007 including Appendix J

   d. All air conditioning systems shall be equipped with filters having efficiencies no less than those indicated in Table 6-1., Part-6 (ASHRAE 170) Guidelines for Design of Health Care Facilities 2010. Where
two filter beds are required, filter bed No. 1 will be located upstream of the air conditioning equipment and filter bed No. 2 will be downstream of the supply fan.

e. The system serving Protective Environment rooms shall be provided with a tertiary terminal HEPA filter in addition to filter beds No. 1 and 2.

19. Noise criteria design conditions:

a. The mechanical systems shall be designed to conform to the following design criteria for noise in interior spaces:

<table>
<thead>
<tr>
<th>Room Type</th>
<th>NC/RC(N)/RNC Criteria Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Rooms</td>
<td>35-45</td>
</tr>
<tr>
<td>Patient Rooms</td>
<td>30-40</td>
</tr>
<tr>
<td>Laboratories</td>
<td>40-50</td>
</tr>
<tr>
<td>Corridors</td>
<td>35-45</td>
</tr>
<tr>
<td>Public Areas</td>
<td>35-45</td>
</tr>
<tr>
<td>Administrative Areas</td>
<td>35-40</td>
</tr>
</tbody>
</table>

20. Crimp or press fittings are not acceptable.

21. Butterfly valves are unacceptable at NYPH-WCMC for steam use only

a. Acceptable in other instances pending review.

22. All isolation rooms pressure monitors and tracking pairs shall be monitored by the BMS.

23. Engineer is to coordinate the choice of control valves manufacturer with OFO.

24. At the completion of every project the contractor shall be required to provide fixed sheaves on all fans.

25. Fan Walls:

a. Explore the use of fan wall technology to increase AHU footprint flexibility, redundancy, eliminate the exposure of downtime due to mechanical failure.
b. One VFD shall not be used to control the whole fan array due to lack of redundancy.

c. Provide one VFD for a maximum of four fans within the total array for stand alone units.

d. Provide a minimum number of VFD for fan wall + 100% standby (backup).

e. Site specific bifurcated/split AHU VFD configuration shall be as follows. One VFD per bank, if one VFD fails the other will pick up. Isolation switches between the distribution block and drive to keep units running.

f. CUMC OnSite reference: CHONY Infrastructure AHU configuration; location North Roof and 13th Floor MER

26. VAV Zoning:

a. Provide individual terminal units for each patient room.

b. Provide individual terminal units for conference rooms.

c. No more than three non-patient rooms shall be connected to a single terminal unit.

d. Single-zone, constant volume terminal units are to be used for rooms where once-through ventilation is required such as toilet rooms and janitor’s closets.

e. Zones shall have similar load characteristics. Perimeter zones shall only be grouped with the same orientation of glass. Interior spaces should not mix with perimeter zones.

f. Terminal units for unoccupied areas in medical office spaces shall have night setback and override capability through featured thermostat from the building automation system.

g. Specify single duct variable volume terminal units (except where space protocol and applicable Code/Standards merit otherwise) with hot water zone heating coils for patient care areas.
h. Locate terminal units for full maintenance access above the ceiling. Ensure that all terminal unit controllers and operators are located minimum 24 inches from any obstruction (walls, pipe, etc.). Provide a minimum 42 inch clearance (per NEC) for access to electrical panels on terminal units. Furniture floor plan shall not block VAV access.

i. Protective Environment Rooms, Isolation Rooms and Operating Rooms will require VAV terminal boxes that are capable of maintaining a constant offset between supply air and return or exhaust air from the space which is dependent on the function of the room.

j. Differential pressure monitors shall be provided to maintain required pressure differential. Hot water reheat coils are used to temper room temperature settings.

k. Perimeter heat shall be smooth radiant panels with exposed cleanable surfaces in areas designated by FGI Healthcare Guidelines.

l. For all occupied patient spaces, both exterior and interior zones, the minimum hot and cold settings of terminal units shall be such that minimum ventilation needs per the standards for the occupants are met at all times.

m. Thermostats should be located on the plans and specified to be mounted at 3’ to 4’ above the finished floor with gasketing on the control wiring to prevent bias of sensors from air leaking from the wall behind the thermostat.

n. Avoid mounting thermostats on exterior walls where exterior heat gains, losses and infiltration can result in false readings. If mounting thermostats on exterior walls is unavoidable, specify rigid insulation between the thermostat backplate and the wall.

o. When placing thermostats in the space, review the furniture plans and avoid locations near heat producing equipment, locations that can receive direct solar radiation.

p. VAV with reheat shall have temperature sensor downstream to monitor supply air temperature.
q. Corridors to have flush mounted sensors (where they can’t be knocked off of walls).

r. Typical OR to have local display with humidistat, temperature, and pressure monitored.

27. Room pressurization:

   a. Room pressure monitors shall be similar to Siemens 547.

   b. Provide room pressure sensors with the pressure range of +/- 0.25 in.w.c. and accuracy of 0.25%, P1 interface.

   c. Configure the initial setpoint at 0.1 in.w.c. (adj.)

   d. Protective Environment Rooms, Isolation Rooms and Operating Rooms will require room pressurization monitors.

   1) Required Locations:

      a) Doors to OR from either Sterile Corridor or Sub-Sterile Corridor

      b) Door between Sterile Corridor and regular corridor

      c) Not required at door between regular corridor and sub-sterile corridor

   e. Clean rooms, soiled utility rooms and other pressurization required rooms to have individual VAV terminals and cannot be combined with other areas unless air terminal is set to constant volume.

28. Air handling units to be equipped with UV lights on the cooling coils. Request must be made to FO if project cannot accommodate.

   a. UV lights to be monitored at the BMS

   b. Compliant w/ OSHA and NIOSH

29. Motors:

   a. Inverter duty motors to be standard
b. Solid State Overload Motors with overload protection shall be used for small motors.

c. Motor Starters require solid state overload relays

d. NEMA enclosure shall be used if available with equipment and space allows. If not, IEC enclosure is acceptable.

e. WCMC: VFD’s shall only have manual bypass.

30. WCMC: All HVAC systems shall incorporate air flow measuring stations to accurately control supply, return and outside air design flow.

31. Any motor that will be installed in an AHU that might see any type of moisture should be ODP to prevent any moisture entering the windings and shorting out the motor

32. CU: Specify 10 Micron sand filtration.

33. Fuel Oil Leak Detection:

a. WCMC: Submit detection system to Facilities Office for approval

b. CUMC: Leak detection for underground storage shall be similar to Milstein Fuel Oil project Phase 1&2, coordinate w/ Facilities Office.

34. Refrigerant Monitoring System:

a. WCMC: MSA ChillGuard IR is not acceptable, Bacharach is an acceptable manufacturer.

35. Coordinate filter manufacturer and model numbers with facilities office.

36. Resiliency

a. Underground Fuel Storage shall be anchored and design and installed to prevent flotation, collapse, and lateral movement from hydrostatic forces. Additional capacity and storage location requirements per NYC BC G307 and G310.6 and G304.
1.2 ENERGY CONSERVATION FEATURES

A. The project shall be designed to meet New York State and City Energy Conservation Construction Code as a minimum, where it does not impact the requirements of FGI Guidelines for Design and Construction of Health Care Facilities. Energy Compliance Guideline of NYPH standards shall be followed to meet New York City Department of Buildings plans approval requirements. Where applicable the engineer shall coordinate with the NYPH PM an application for any state and local energy efficiency grant opportunities to minimize upfront capital investments (i.e. NYSERDA, Con Edison).

B. Additional energy conservation features to be considered are as follows:

1. Dry bulb or enthalpy controlled economizer cycle for air conditioning systems, to take advantage of cool outside air to provide space cooling without or with reduced usage of refrigeration system.

2. Provisions for reducing the air flow requirements during unoccupied periods for the following rooms:
   a. Operating rooms.
   b. C-section and delivery rooms.

3. All air handling systems shall be zoned to serve areas with similar function and occupancy periods.

4. Use of variable air volume type air conditioning systems for areas which do not require constant humidity or where ventilation requirements are not compromised.

5. Larger temperature differential (supply – return temperature) for water systems to minimize pumping power consumption for water circulation. Primarily, this will involve application of chilled water system with temperature differentials of 12°F to 16°F and heating hot water system with temperature differential of 160°F to 190°F.

1.3 SUBSTITUTIONS
A. No substitute material or manufacturer of equipment shall be permitted without a formal written
submittal to the engineer which includes all dimensional, performance and material
specifications and is approved in writing by the engineer. Any changes in layout or design
brought about by the use of a substitution shall be submitted to the engineer fully designed for
review in conjunction with the submittal of the alternate. Any substitution must be submitted
with an explanation why a substitution is being utilized. If the substitute is being utilized for
financial reasons, the associated credit must be simultaneously submitted. Final acceptance or
rejection of any substitution is subject to the NYPH OFO’s review.

1.4 CODE COMPLIANCE
A. All HVAC work shall comply with the latest applicable editions of the following codes:
   1. New York State and City Building Code.
   2. New York State and City Mechanical Code.
   3. New York State and City Electrical Code.
   6. Codes and Rules and Regulations of State and City of New York.
   7. NYC Department of Health and Mental Hygiene

1.5 STANDARDS
A. American National Standard Institute (ANSI)
B. American Society of Testing Materials (ASTM)
C. National Fire Protection Association (NFPA)
D. Underwriters Laboratory (listed) (UL)
E. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACHA)
F. American Society of Mechanical Engineers (ASME)
G. Air Movement and Control Association (AMCA)
H. Air Conditioning and Refrigeration Institute (ARI)
I. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
J. National Environmental Balancing Bureau (NEBB)
K. Associated Air Balance Council (AABC)
L. National Electrical Manufacturers Association (NEMA)
M. Environmental Protection Agency (EPA)
N. National Institute for Occupational Safety and Health (NIOSH)
O. Occupational Safety and Health Association (OSHA)

1.6

A.

END OF SECTION
BASIS OF DESIGN-CLEAN STEAM

1.1 CLEAN STEAM DESIGN CRITERIA

A. The following pages contain guidelines for the implementation of clean steam for renovated facilities at the New York Presbyterian Hospital. They shall be used by A/E firms in the preparation of drawings and specifications for construction of facilities.

1. The Guidelines are not Contract Specifications, but used to prepare more detailed, project specific specifications. The guidelines provide a minimum criteria for the steam quality utilized for humidification and sterilization for applications where contaminants such as boiler feed water chemicals, scale and corrosion particles make plant steam unsuitable.

2. The use of these clean steam guidelines is mandatory for all design or maintenance projects and coordination w/ NYPH is essential to ensure project requirements are met. Deviations are discouraged. If project conditions arise which require a deviation, it shall be thoroughly documented by the user and submitted to the NYPH for review and approval.

1.2 FEEDWATER REQUIREMENTS

A. Water Quality Water entering humidifiers/sterilizers shall originate from one of the following sources.

1. Softened water (hardness reduced through an ion exchange process)
2. High-purity water (deionized and/or reverse osmosis treated water)

B. Producing pure steam meeting USP criteria for Water For Injection requires the feedwater that is demineralised / reverse osmosis water free of silica, chlorine, amine and volatile substances.

Distillate quality

<table>
<thead>
<tr>
<th>Property</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.0 – 7.0</td>
</tr>
<tr>
<td>Conductivity</td>
<td>≤ 1.3 µSiemens @ 25°C</td>
</tr>
<tr>
<td>Chlorides</td>
<td>Absent</td>
</tr>
<tr>
<td>Sulphates</td>
<td>Absent</td>
</tr>
<tr>
<td>Calcium</td>
<td>Absent</td>
</tr>
</tbody>
</table>
Metals Absent  
Nitrates Absent  
Micro-organisms Absent  
Total bacteria count $\leq 10$ cfu / 100 ml  
Total organic carbon $< 0.5$ ppm  
Endotoxin $< 0.25$ EU / ml  

C. To meet the requirements of HTM 2031, it is recommended the use of de-mineralised or reverse osmosis feedwater. It is advised that analysis of the feedwater is undertaken prior to installation and commissioning. Whilst not mandatory the table opposite gives a guide to recommended typical values.

<table>
<thead>
<tr>
<th>Property</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium</td>
<td>0.2 mg / l</td>
</tr>
<tr>
<td>Heavy metals substitute</td>
<td>0.1 mg / l</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.5 mg / l</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0.2 mg / l</td>
</tr>
<tr>
<td>Residue on evaporation</td>
<td>30.0 mg / l</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.1 mg / l</td>
</tr>
<tr>
<td>Silicate</td>
<td>0.1 mg / l</td>
</tr>
<tr>
<td>Electrical conductivity at 25°C</td>
<td>35.0 $\mu$S / cm</td>
</tr>
</tbody>
</table>

1.3 CLEAN STEAM FOR HUMIDIFICATION

A. Humidification is the process of transforming water into vapor. The water type has a great impact on humidifier performance, maintenance requirements, humidification vapor quality, and efficiency of operation.

Some humidification applications require steam that has no impurities. For these applications, boiler steam is often derived from deionized (DI) water and then dispersed into the air through clean-steam humidifiers.

Clean-steam humidifiers are typically used in environments with exacting temperature, air cleanliness, and humidity requirements such as hospitals, clean rooms, laboratories, and pharmaceutical spaces.

Using on site steam for humidification can be a good economic choice. Pressurized steam can be injected directly into the airstream, or passed through a heat exchanger to heat potable, softened, or DI/RO water for humidification steam.
B. Chemically-treated boiler steam may affect indoor air quality. Many humidifier users are finding that chemically treated, boiler-generated steam is unsuitable for direct injection humidification. This is because boiler water is treated with anticorrosion chemicals that are emitted with the steam into the occupied space. These chemicals can irritate eyes, skin and aggravate respiratory disorder such as asthma.

1. Boiler steam/condensate systems are subject to corrosion due to the presence of carbon dioxide in the condensate pipes coupled with availability of oxygen and high temperature. CO2 is produced when carbonate and bicarbonate alkalinitities in boiler feedwater thermally decompose in the boiler. The carbon dioxide is carried with the steam and then dissolves in the condensate to form carbonic acid, which accelerates corrosion in condensate piping, receivers, and steam traps. If the carbonic acid is not addressed, corrosion will severally damage the entire condensate system and corrosion byproducts can be carried back to the boiler causing additional damage. To minimize condensate system corrosion most central plant boiler systems utilize condensate corrosion inhibiting chemicals called neutralizing amines. Neutralizing amines are volatile alkaline compounds that are added to the boiler feedwater. These amines flash off with the steam and when the steam condenses the amines neutralize the resulting carbonic acid to prevent corrosion in the condensate system.

2. The three most common neutralizing amines are cyclohexylamine (CHA), morpholine, and diethylaminoethanol (DEAE). These chemicals have been associated with upper respiratory, eye, and skin irritations. Due to this concern the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental and Industrial Hygienist (ACGIH) have established regulatory and advisory limits for these chemicals. These limits are intended to protect worker safety.

C. Steam-to-steam converter system

1. A steam-to-steam converter system can utilize onsite steam while creating very pure humidification steam. Instead of injecting boiler-generated steam directly into the airstream, boiler steam is used as an energy source to heat a second pressurized vessel filled with deionized water, creating clean steam for humidification. The use of deionized water requires that the humidifier and valves be fabricated completely in stainless steel.
2. This system is used in applications where superior control, high-purity steam, and maintenance-free humidification take high priority to justify the higher cost.

D. Steam-to-steam evaporative humidifier

Campus boiler steam can be utilized through the a heat exchanger of an evaporative humidifier tank. This steam-to-steam system is a cost-effective way to provide humidification free of boiler chemicals while using on-site boiler steam as the energy source. Evaporative steam-to-steam systems can use tap, softened or DI/RO (deionized/reverse osmosis) makeup water, offering a range of solutions to meet almost any humidification need. Systems using DI/RO makeup water provide the tightest control, the cleanest humidification steam and require almost no maintenance, but also require higher quality equipment. Standard water systems use either hard tap or softened water, with water level control systems designed to skim or flush precipitated minerals.

1.4 CLEAN STEAM FOR STERILIZATION

A. Steam sterilization involves the use of steam under pressure, delivered at a particular temperature for an appropriate time. Sterilization occurs as the latent heat of condensation is transferred to the load causing it to heat rapidly. Heating denatures any microorganisms remaining following the cleaning process. Wrapped and packaged items must be thoroughly dry prior to removal from the autoclave and procedures must be in place to monitor the sterilization process.

B. Steam quality

1. Steam quality affects the degree of sterilization and dryness of processed materials.

2. There are three categories of steam quality that will hinder the efficacy of the sterilization process:
   a. Moisture content of steam (dryness fraction)
   b. Non-condensable gases, e.g.: air content of steam
c. Particulate or chemical contamination carried in the steam arising from an impure water supply (from which the steam is generated) or improper operation of the boiler or steam generator.

C. Moisture content

1. A continuous supply of dry saturated steam is required for reliable steam sterilization. This is steam that is not too wet and not too dry. Excess moisture carried (suspended or entrained) in the steam may cause wet loads, while superheated steam is a problem for reliable sterilization because it is dry and needs to cool before its moisture (necessary for fast killing of microorganisms) becomes available. Steam in the Sterilizer may become superheated during expansion into the chamber from a much higher pressure, or it may be produced through malfunction of some Sterilizer or steam supply components.

2. The moisture content of the steam (dryness fraction) is measured as the weight of dry steam present in a mixture of dry saturated steam and entrained water. Ideal steam for sterilization is 100% dry saturated steam, although in practice, values greater than 97% are considered acceptable. Inferior moisture content quality can occur due to factors such as boiler priming and poorly trapped steam supply lines. Similarly, superheated steam is to be avoided.

D. Non-condensable gases

1. Non-condensable gases are those which do not exhibit a change between gas and liquid states in the normal operating range of temperatures of a steam Sterilizer. They seriously interfere with the heat plus moisture conditions necessary for microbial death. The presence of air inhibits steam contact to surfaces.

2. Air is generally ‘incondensable’ and may be trapped in steam being delivered to a Sterilizer. The removal of non-condensable gases can be facilitated by the installation of air vent assemblies at high points on the steam line before the sterilizer.

3. Levels of non-condensable gases (e.g. air) should be at a level that will not impair steam penetration into sterilization loads. The level is expressed as less than 3.5% v/v condensate.

E. Steam quality testing
1. In order to ensure that the end product is as pure as possible, a number of tests can be performed to test steam quality. Results within the specified acceptable levels will show that the quality of steam introduced into the Sterilizer is not harmful to the load.

2. Steam quality testing is recommended during the commissioning of a Sterilizer and or Steam boiler to establish base line data.

3. Coordinate with the sterilizer manufacturer to evaluate steam quality.

1.5 PIPING

A. All clean steam piping distribution and accessories shall be 316l stainless steel.

1.6 Clean Steam Generator Manufacturers

A. Spirax
B. Reco
C. Armstrong
D. Cemline
E. Any other manufacturer where clean steam generator is already installed on campus.

1.7 STANDARDS AND CODE COMPLIANCE

A. ASHRAE 62.1 & 170
B. UNI EN 285.
C. HTM 2031
D. HTM 2010
E. FDA - Guide to inspection of high purity water systems.
G. European Commission - Good Manufacturing Practices.
I. European Pressure Equipment Directive 97 / 23 / EEC.
J. CFR 21 Part 11.
K. USP 36-Water for Pharmaceutical Purposes
L. USP29
M. ANSI/AAMI ST79

END OF SECTION
ELECTRICAL– BASIS OF DESIGN
ELECTRICAL– BASIS OF DESIGN

1.01 BASIS OF DESIGN

A. Electric Service Characteristics (for new construction only):
   1. Review service voltage options with utility company and NYPH personnel.
   2. Review initial installation costs vs. operating costs.
   3. Review utility rates for various service options.

B. Load Estimate:

Loads shall be estimated, calculated and verified at each stage of preparation of construction documents (Schematic Design-SD, Design Development-DD and Construction Documents-CD).

1. Normal Load:
   a) The following watts per square foot may be used for preliminary load estimate and must be verified at each stage of design:

<table>
<thead>
<tr>
<th>Functional Areas</th>
<th>Lighting Load</th>
<th>Floor Power Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>3 W/sq ft</td>
<td>2.5 W/sq ft</td>
</tr>
<tr>
<td>Corridors</td>
<td>1 W/sq ft</td>
<td>.25 W/sq ft</td>
</tr>
<tr>
<td>Mechanical Spaces/Storage</td>
<td>.7 W/sq ft</td>
<td>.5 W/sq ft</td>
</tr>
<tr>
<td>OR’s</td>
<td>7 W/sq ft</td>
<td>10 kva per OR</td>
</tr>
<tr>
<td>ICU’s</td>
<td>3 W/sq ft</td>
<td>2.5 kva per ICU bed</td>
</tr>
<tr>
<td>NICU’s</td>
<td>3 W/sq ft</td>
<td>1.0 kva per bassinet</td>
</tr>
<tr>
<td>Patient Beds</td>
<td>3 W/sq ft</td>
<td>.72 W per bed</td>
</tr>
<tr>
<td>Mechanical Loads</td>
<td>N/A</td>
<td>4.5 W/sq ft</td>
</tr>
</tbody>
</table>

   b) Program specific loads must be added, such as:

      1) Elevators/escalators
      2) Pneumatic tube
      3) Radiological equipment
      4) Kitchen equipment
      5) Sterilization equipment
      6) Etc.

2. Emergency Load:
Emergency load calculations are generally driven by the specific project scope. Calculations shall be based on the following:

b) Minimum code requirements (most stringent codes shall be used).

c) Additional Owner’s requirements.

C. Distribution Systems:

Distribution system characteristics depend on the service characteristics, and must be tailored for specific NYPH Campus. The following is recommended:

1. Normal:
   a) 460/265 volt, 3 phase, 4 wire for:
      1) Fluorescent, high intensity discharge lighting.
      2) Motors, ½ hp and larger.
      3) Radiological equipment.
   b) 208/120 volt, 3 phase, 4 wire, derived from stepdown transformers for:
      1) Incandescent lighting.
      2) Receptacles.
      3) Motors, less than ½ hp.

2. Emergency:

Emergency distribution shall be based on minimum code requirements and additional Owner’s requirements:

a) Minimum code required systems shall include the following:

   Essential electrical systems: The essential system shall be comprised of three separate systems capable of supplying emergency power during power failure: life safety, critical and equipment. The percentage of devices and equipment on emergency power shall be as required by code and as per acceptable engineering practice.

   1) Life Safety:
      a) Egress lighting.
      b) Exit signs.
c) Fire alarm system.
d) Communications systems used for issuing instructions during emergency conditions (telephone, PA or both).
e) Lighting and receptacles in generator room.
f) Medical gas alarm system.
g) Elevator cab lighting.

2) Critical (lighting and power):
a) Telephone equipment rooms.
b) Electric rooms.
c) Anaesthetizing locations.
d) Patient care area (see NFPA 99 for specific lighting and power requirements).
e) Nurse call system.
f) Blood, bone and tissue banks.
g) Acute care beds.
h) Cardiac catheterization labs.
i) Coronary care units.
j) Hemodialysis rooms.
k) Emergency rooms.
l) Recovery rooms.
m) Delivery rooms.
n) Operating rooms.
o) Intensive care units.
p) Emergency admitting.

3) Equipment:
a) Vacuum system serving medical and surgical functions.
b) Compressed air system serving medical and surgical functions.

c) Sump pumps.

d) Heating equipment for operating, delivery, recovery, intensive care, coronary care, nurseries and general patient rooms.

e) Elevators (any 3 elevators at a time, minimum one elevator per bank). All elevators shall be capable of returning to first floor in sequence from stand-by power source (NYC BC 3003.1.3)

f) Supply and exhaust ventilating systems for surgical and obstetrical delivery suites, infant nurseries, laboratory fume hoods, emergency treatment spaces.

g) Environmental control system.

h) Automatic doors.

i) Electrically heated autoclaving equipment.

j) Smoke control and stair pressurization system.

k) Security system.

l) Generator auxiliaries (see Mechanical Section).

m) Kitchen and labs refrigerators and freezers.

n) Steam machine auxiliaries and controls.

b) Additional Owner’s requirements:

1) Equipment branch:

   a) Emergency cooling capability for Operating Rooms, ICU’s and Isolation Rooms.

2) As directed by NYPH for specific project.

D. Raceways shall use use steel set-screw fittings or unicouple connectors for EMT conduits. Compression fittings on a per design basis with FO approval.

E. All emergency branch circuits are to be run in conduit. Normal branch circuits are permitted to be run in hospital grade type HCF-90 cable with F.O. approval only.

F. Use arc-proof wrapping around each feeder 100A and above in common pull boxes where two or more feeders are run thru same box at CUMC.
G. All branch circuits shall be run with dedicated neutral conductors. Shared neutrals and multi-pole (common trip) circuit breakers for independent loads shall not be permitted.

H. Isolation Power systems (example Operating Rooms) branch circuits shall utilize type XHHW conductor insulation. THHN/THWN shall not be permitted for this application.

I. All boiler plant wiring for branch circuits and controls shall be high temperature rated.

J. All main and tie switches 1200A and above shall be high pressure contact (HPC) type. Removed bolted pressure (BPS) switch type. Requirement for high pressure contact (HPC) at WCMC is 800A and above.

1. WCMC: Any ATS 400A and above shall have a bypass.

K. All CUMC switchboards and panelboards shall be manufactured by All-City, Atlas, or Lincoln Electric. Switchboard manufacturers shall use only Siemens components. Only non-national branded equipment is acceptable. Same requirement for WCMC for 800A and above.

L. Switchboards shall be bolted to concrete pads or welded to concrete pad steel structural elements. High tension equipment shall be mounted to steel rails in pad.

M. Fail safe GFCI circuit breakers shall be used in lieu of GFCI receptacle devices at CUMC. GFCI receptacles are permitted at WCMC.

N. All ATS shall be 4-pole, overlapping neutral, isolation by-pass type and shall have accessory 30B – load shed, 72E – serial communicator, and 23B – power monitor. Provide remote annunciators.

O. All fuses shall be Bussman yellow low-peak type.

P. All transformers 150kVA and below shall be Hazard Location Encapsulated type, NEMA 3R. Core & coil shall be encapsulated with resin compound sealing out moisture and air.

Q. Wiring devices shall be Hubbell hospital grade only.

R. WCMC: Any tamper resistant outlets shall be Hubbell Hospital grade only.

S. GFCI circuit breakers shall be used in lieu of GFCI receptacle devices at CUMC.

T. Emergency receptacles shall be back-lit illuminated type at CUMC only.

U. Receptacle color coding shall be:

1. Normal: White or per Architectural design.

2. Emergency: Red (and back-lit at CUMC only.)

V. Receptacles shall be tamper resistant integral shutter-type in all public waiting areas and pediatric areas, including ICUs. O.R.’s are exempt.
W. Headwall device emergency circuits shall not be shared between headwalls. Normal circuits are permitted to be shared within permissible load constraint.

X. Motors shall have minimum 95% Efficiency and shall be inverter duty, compact winding type and shall be VFD driven. Small duty motors with conventional motor controllers shall be solid-state overload relay type.

Y. ABB is the VFD design standard.

1. All motor shall be VFD compatible.

Z. Resiliency

1. Per ERIC interpretation and NYC BC 2014, legally required stand-by loads can be configured on the hospital EES as emergency loads. Optional stand-by loads cannot be configured as emergency. Coordinate legally required stand-by loads per NYC BC 403.4.7 with existing hospital EES requirements.

2. All main service disconnecting means and circuit breakers shall be located above and accessible from above the design flood elevation per NYC BC G501.1 and G310.6 and G304.

AA. All light fixtures shall be chain supported regardless of weight.

END OF SECTION
PLUMBING – BASIS OF DESIGN
1. Design Criteria:
   A. The storm water drainage system will be designed based on a 100 year hourly rainfall rate of 3” per hour. Secondary drainage or scuppers shall also be provided. Where secondary drainage systems tie into the primary drainage system, the combined primary and secondary system shall be sized based on their combined rainfall rate of 6” per hour.

   B. Hot water heater discharge temperature to be set at 112 degrees. Tempering valves, set at 110 degrees, to be provided at all public, patient lavatories and exam room sinks. Hot water heaters to be set at 140 degrees where kitchen equipment is involved. Where higher temperature hot water is required, equipment will be provided with a booster heater.

   C. Water closets will be wall hung flushometer type.

   D. Patient toilet rooms will contain a water closet with bed pan lugs and bed pan washer.

   E. All patient room toilet lavatories and sinks in patient rooms to have overflow drains.

   F. Showers and tubs will include thermostatic and pressure balanced mixing valves.

   G. In addition to pressure balanced mixing valve for showers each shower shall have an additional thermostatic mixing valve located in ceiling with access doors.

   H. Electric water coolers will be stainless steel with integral chiller units.

   I. Fixtures will be provided for the handicapped.

   J. All materials used on a project will meet New York City Building Code requirements and where require, these materials will also comply with NFPA, UL and ASME Standards.

   K. Domestic water systems will be designed to maintain a maximum velocity of 6 feet per second at design flow conditions.

   L. Maximum water pressure at any plumbing fixture will be 80 psig.

   M. Systems will be designed to prevent water hammer conditions by providing shock arrestors for flush valve fixtures and quick closing valves.
N. All shock arresters located in walls or sheetrock ceilings to have access doors.

O. Waste from fixtures and floor drains located below grade will drain by gravity to duplex sewage ejectors or sump pumps and pumped to gravity house drains.

P. All equipment will be duplex as a minimum, with one pump used as stand-by.

Q. A minimum of two (2) water services will be provided for all new facilities with backflow preventers on each service.

R. All hot water piping systems will be designed with a piped recirculated system having duplex circulating pumps. Hot water temperature maintenance is not accepted. A minimum of two (2) risers will be provided on each supply system to any area with valve connections on each service.

S. Crimp or press fittings are not acceptable.

T. Grooved fittings are only permitted on domestic cold water and hot water piping exposed to view.

U. All relocations of plumbing or medical gas risers/stacks shall be approved by NYPH-FO.

V. Solenoid and pressure switches to be installed on all cold water makeup lines.

W. Medical gas sensors to be located in area alarm panel. Sensors to be connected to the medical gas pipeline via copper tubing.

X. Medical gas shut off valves to be dual port with locking handle.

Y. Piping, components and equipment subject to sweating, heat loss or freezing will be insulated with appropriate thickness of fiberglass and fire-retardant and/or weatherproof.

Z. Motor operated equipment will be provided with vibration isolation mounting and connecting piping with vibration isolation hangers, to prevent transmission of vibration or noise to the building.

AA. CUMC campus - all sensor fixtures to be hardwired for power.

BB. WCMC campus - all sensor fixtures to be battery powered.

CC. Use of electric water heaters to be approved by FO on an individual basis.
2. Energy and Water Conservation Features:
   A. Water conserving water closets with a maximum of 1.28 gallons per flush for water closets in patient rooms (bedpan washer flushometer) and 1.28 or dual flush 1.6 /1.1 gallons per flush in public toilets.
   B. Public and staff lavatories shall have 0.25 gallons per metering cycle and 0.5 GPM at 60 PSI for faucets other than metering. 1.5 gallons per minute for patient lavatories and staff work sinks.
   C. All flow restrictors to be laminar flow type
   D. 2.0 gallon per minute flow restrictors for patient room showers.
   E. Utilizing 110°F hot water restrictors for patient room showers.
   F. Appropriate insulation will be provided on domestic hot and cold water distribution systems and water heaters.

3. Code Compliance:
   Systems will be designed in accordance with the following applicable codes.
   A. New York City Building Code effective January 2015 and all current Amendments.
   B. FGI 2014 Guidelines for Design and Construction of Hospital and Healthcare Facilities
   C. Seismic Zone 2 requirements as adopted by New York City Code.
   F. The New York State Energy Code.
   G. Americans with Disabilities Act (ADA).
   H. NYC Department of Health and Mental Hygiene
   I. Lead-Free Certifications: Provide manufacturer’s certification that valves, water submeters etc. in contact with the potable water meet the requirements of the Reduction of Lead in Drinking Water Act effective Jan 4, 2014.
4. Reference Standards:
   B. ANSI – American National Standards Institute.
   C. ASME – American Society of Mechanical Engineers.
   F. UL – Underwriters’ Laboratories, Inc.
   G. PDI – Plumbing and Drainage Institute.
   H. OSHA – Occupational Safety and Health Administration.
   I. ASSE – American Society of Sanitary Engineering.
   J. CISPI – Cast Iron Soil Pipe Institute Copper Development Association, Inc.
   K. National Safety Foundation.

5. Inspection of Site Conditions:
   A. Prior to start of construction documents, visit the site to examine the existing services.
   B. Prepare sketches indicating locations, size and number of openings required in walls and ceilings to confirm existing piping.

6. Connections to Existing Work:
   A. Install new work and connect to existing work with minimum interference to existing facilities.
   B. Schedule all shutdowns so as not to interfere with normal operations of existing facilities with NYPH engineering staff.
   C. Maintain continuous operation of existing facilities as required with necessary, temporary connections between new and existing work.
D. Connect new work to existing work in neat and acceptable manner. Restore existing disturbed work to original condition.

7. Removal of Existing Work:
   A. Plug or cap affected lines behind or below finish at connection to main line or riser. Provide shut-off valve at connections.

8. Clearance from Electrical Equipment:
   A. No plumbing piping shall be routed in or through electric closets, telephone closets or elevator machine rooms.

9. Drip Pans:
   A. Provide drip pans under and/or around piping when installation over or within 5 feet of electrical apparatus is unavoidable or in room containing electrical equipment. Provide enclosed type drip pan when required for pressure piping. Pan shall be 16 gauge galvanized sheet metal reinforced, properly supported and made watertight. Extend 1-1/4 inch drain pipe from pan to spill over nearest floor drain or mop sink.

   Provide leak detection system to sense water in area being monitored and send signal to notify personnel of pending water issue. Leak detection system shall have module that will receive power for system and send required signal/alarm, modular leader cable, sensing cable, splices, end terminations, relays, etc, for complete and operational system.

10. Accessibility:
    A. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.
    B. Group concealed valves, controls and equipment requiring access, so as to be freely accessible through access doors.
    C. Minimum size access door shall be 18 inches x 18 inches.

11. Pipe and Equipment Identification:
    A. All piping and equipment shall be identified.
B. When removable ceiling tiles are provided, install buttons, tables or markers to identify location of concealed work and/or valves.

C. Provide tags on all valves and controls identifying number of valve and system.

D. Provide nameplates on all equipment, valve boxes and alarm devices indicating pump characteristics, system, pressure, etc.

E. Provide valve and nameplate charts indicating number, system, type, size, location of all valves and equipment.

F. Provide pipe markers on all piping indicating system and direction of flow.

12. Pipe Supports:

A. All horizontal and vertical piping shall be supported at distances indicated in the New York City Code.

B. Supporting piping is intended to secure piping in place, maintain required pitch, prevent vibration and provide for expansion and contraction, using hangers, supports and inserts.

C. Support all piping independently from building structure by proving expansion anchors, beam clamps and acceptable brackets.

D. Support all branch piping to fixtures in pipe chases.

13. Testing:

A. All piping systems shall be tested. Perform all tests in the presence of NYPH staff for a duration of 2-8 hours depending on size and complexity of system (hours to be coordinated with NYPH staff).

14. Water Heaters

A. Water heaters to be instantaneous type (steam to water).

15. Medical Vacuum Pump/ Medical Air Compressor

A. Medical vacuum pumps shall be oil free factory assembled, wired, piped and tested electric motor driven air cooled continuous duty vacuum pump. Pumps to be Claw type with Variable Speed Drive. As manufactured by Beacon Medaes
B. Medical Air Compressor shall be oil free rotary or scroll as manufactured by Beacon Medaes

16. All sump pumps, ejectors and booster pumps shall be connected to emergency power

17. Insulation
   A. Extend insulation unbroken through hangers and sleeves
   B. Insulate all water piping at fixtures and equipment including concealed piping in pipe chases, except do not insulate chrome plated water piping at fixtures and equipment.

18. Resiliency
   A. Medical, compressed, and cryogenic gas containers including medical gases, oxygen, and other gases shall be located above the design flood elevation AND the 500-year flood elevation per NYC BC G307.5 and G310.6 and G304.

END OF SECTION
FIRE PROTECTION BASIS OF DESIGN

1. DESIGN CRITERIA
   A. The fire protection systems shall be designed in accordance with the applicable requirements of the listed referenced codes and standards, the Authorities having jurisdiction, Hospital’s Insurance Underwriters and the latest good design practice.
   B. New building structures and total or partial renovation of existing building facilities shall be provided with a combined fire standpipe-sprinkler system.

2. FIRE STANDPIPE HOSE STATION SYSTEMS
   A. Fire hose stations with 2-1/2” valve and 125 ft of 1-1/2 inch of hose, shall be provided on every floor within stairwells and additional auxiliary fire hose cabinets shall be provided throughout the floor(s) as required to provide total coverage.
   B. Fire hose stations shall be supplied by the combined fire standpipe-sprinkler risers.

3. SPRINKLER SYSTEMS
   A. New building structures and total or partial renovation of existing building facilities shall be fully sprinklered, supplied by the combined fire standpipe sprinkler risers.
      2) Sprinklers shall be installed in all electric equipment rooms and switchgear rooms 480 volts and below.
      3) Any other exceptions shall be reviewed with and approved by the Owner and their Insurance Underwriters.
   B. Hydraulic calculations shall be submitted for any sprinkler system design layout including alteration of the existing sprinkler system.
   C. Design and hydraulic calculations of new and alteration of existing sprinkler systems shall conform to the following criteria:
      1) Light Hazard – public areas, lobbies, corridors, offices, patient rooms, examination rooms, computer and data entry rooms and other areas with low combustible contents: Density of 0.10 gpm per square foot over 1,500 square feet area of application. 225 square feet maximum coverage per sprinkler head.
2) Ordinary Hazard Group 1 – laboratories, pharmacies, packaged chemical storage, clean linen, soiled linen collection and sorting, refuse collection and sorting, storage rooms, (storage less than 12 feet height), kitchens, servery area, cafeteria seating area, auditorium, public assembly, mechanical equipment rooms, electric and telephone equipment rooms, laundry room:
density of 0.15 gpm per square foot over 1,500 square feet area of application; or entire area where less than 1,500 square feet, including two sprinkler heads outside of each door and window to adjoining space, but in no case shall the calculated area of application be less than 1,500 square feet, 130 square feet maximum coverage per sprinkler head.

3) Ordinary Hazard Group 2 – loading dock, material sorting area, contaminated waste area, compactor area, covered parking or driveway within the building outline, below grade parking, hazardous storage, class B2 storage, flammable storage, fuel oil storage tank room, electric switchgear room:
density of 0.20 gpm per square foot over 1,500 square feet area of application; or entire area where less than 1,500 square feet including two sprinkler heads outside of each door and window to adjoining space, but in no case shall the calculated area of application be less than 1,500 square feet, 130 square feet maximum coverage per sprinkler head.

a) Unheated spaces such as loading docks and open parking or drive through areas below the building shall be provided with a dry pipe sprinkler system with the calculated area of application increased by 30% to 3,900 square feet, or the entire area where less than 3,900 square feet.

b) MRI areas shall be protected by a single interlocked pre-action system activated by heat detectors.

c) Sprinklers shall be required in Electric Switchgear Rooms and Electric Rooms 480 Volts and below

4) Extra Hazard Group 2 – Flammable medical gas storage room:
density of 0.40 gpm per square foot over 2,500 square feet area of application; or entire area where less than 2,500 square feet including two sprinkler heads outside of each door and window to adjoining space, but in no case shall the calculated area of application be less than 2,500 square feet, 100 square feet maximum coverage per sprinkler head.

5) Exterior building wall openings closely spaced sprinkler protection (6’-0” on center) shall be provided on the occupied side at exterior windows or openings between existing and/or new buildings less than 30 feet apart. Piping shall be sized to discharge a minimum of 3 gpm per linear foot.
6) Interior fire divisions – code allowed openings, not provided with opening protective having the required fire resistance rating and/or windows and/or openings on fire rated partitions facing interior court or atrium, shall be provided with closely spaced sprinklers (6'-0” on center) on the occupied side. Piping shall be sized to discharge a minimum of 3 gpm per linear foot.

7) Closely spaced sprinklers (6'-0” on centers) shall be provided around floor slab opening for ornamental unenclosed stair or escalator for no more than two floors. A smoke baffle shall be provided between the closely spaced sprinklers and the edge of the floor slab opening.

8) Combined systems require a check valve at each floor at the sprinkler control valve assembly.

9) In addition to the drain valve assembly at the sprinkler riser a ball valve locked closed drain valve shall be install at the end of the sprinkler system and piped to an indirect waste funnel drain that will discharge to the sanitary system.

4. PORTABLE FIRE EXTINGUISHERS

A. Portable fire extinguishers shall be provided, in addition to sprinklers, throughout new building structures and total or partial renovation of existing building facilities in conformance with the New York City Fire Department Section 906.

B. Portable fire extinguishers in finished areas shall be mounted in cabinets along corridors or exit passageways near the entrance of the protected area and not more than 150 feet (travel distance) from each other and not more than 75 feet (travel distance) from every point on the floor.

C. Portable fire extinguishers in mechanical and electrical equipment rooms, storage, elevator machine rooms and maintenance shops, may be wall hung.

5. CODE COMPLIANCE

A. All fire protection work shall conform with the following codes:


2) New York City Fire Department Directives

3) Codes, Rules and Regulations of the State of New York


5) NFPA 13, Installation of Sprinkler Systems
6) Hose threads shall be Fire Department Standard
7) NFPA 14, Installation of Standpipe Systems
8) NYC Department of Health and Mental Hygiene

6. STANDARDS
   A. NEMA - National Electrical Manufacturers Association
   B. ANSI - American National Standards Institute
   C. ASTM – American Society for Testing and Materials
   D. NFPA – National Fire Protection Association
   E. UL – Underwriters’ Laboratories, Inc.
   F. OSHA – Occupational Safety and Health Administration Regulations
   G. FM – Factory Mutual
   H. Owners Insurance Underwriter

7. FIRE ALARM ZONES
   A. New sprinkler system or partial renovation of existing sprinkler systems’ alarm zoning shall be closely coordinated with the new or existing fire alarm system zones. No work shall be performed without review and approval by the Facility Fire Safety Director.

8. CONNECTION TO EXISTING WORK
   A. Notify facility engineering and schedule shutdown not to interfere with normal operation of existing facilities.
   B. Maintain continuous operation of existing sprinklers, as required, with necessary connections between new and existing. Review and coordinate alarm zones of new and existing sprinkler systems with new and existing fire alarm system zones.

9. CLEARANCE FROM ELECTRICAL EQUIPMENT
   A. Piping is prohibited in electric and telephone rooms and closets, elevator machine room and over or within five feet of transformers, substations, switchboards, motor
control centers, standby power plants and motors except, branch piping supplying sprinklers in any of the above rooms.

10. ADDITIONAL PERMITS

A. In addition to the building and fire department welder qualification and certification requirements, the facility Fire Safety Office requires that person(s) performing work requiring welding obtain a “Hot Work Permit” valid for 24 hours. It must be returned and a new one issued, if necessary. The “Hot Work Permit” states safety precautions and safety procedures to be followed as long as the permit is effective.

B. If work requires entry into a permitted confined space, it is necessary to obtain a “Confined Space Permit” from the facility Fire Safety Office.

11. IDENTIFICATION

A. When sprinkler flow control assembly is located in a room other than a stairwell, a sign shall be provided on the door stating: “Sprinkler Control Valve - Zone…”.

B. When sprinkler test and drain valve is remotely located in a room other than the control valve, a sign shall be provided on the door stating: “Sprinkler Test and Drain Valve – Zone…”.

C. Valve tags shall be provided for every valve in the fire protection system identifying number and system. For sprinkler systems valve tags shall include the sprinkler zone.

D. Control valves for hydraulically calculated sprinkler systems shall be provided with:

1) Permanently attached nameplate indicating the locations(s) and the basis of design(s), discharge density(ies) over designed area(s) of discharge, including gallons per minute and residual pressure demand at base of riser supplied by the sprinkler piping. Such nameplates shall be placed at the controlling shut-off valve, alarm, dry-pipe, or pre-action valve, for the system containing the hydraulically design layout.
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GENERAL PROVISIONS FOR HEATING, VENTILATING AND AIR CONDITIONING
SECTION 23000 - GENERAL PROVISIONS FOR HEATING, VENTILATING AND AIR CONDITIONING WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Work in this Section includes the providing of labor, materials, equipment and services necessary for a complete and safe installation in accordance with the contract documents and all applicable codes and authorities having jurisdiction for heating, ventilating and air conditioning work covered by all sections within the specifications (including but not limited to HVAC systems and equipment).

B. Provide cutting and patching, except as noted in "AIA Document A210" and "Supplementary Conditions for Mechanical and Electrical Work."

C. Provide piping from plumbing terminations, 10 ft from equipment, for water, gas, compressed air and as indicated.

D. Provide drainage from noted equipment to floor drains, roof, sink, or funnel drains.

E. Provide piping connections to equipment, as required, for kitchens, laboratories, laundries, and as indicated.

F. Related Work And Requirements
   1. Requirements of general conditions, supplementary conditions for mechanical and electrical work and Division No. 1.
   2. Requirements noted under other Divisions of Work

1.2 WORK NOT INCLUDED:

1. Providing temporary heat.

2. Providing finish painting including pipe stencilling.

3. Providing access doors and filler.

4. Providing access doors in concrete for access to fuel-oil tanks.

5. Providing trench covers and frames.
6. Providing chimney cleanout door and thimble.
7. Cutting and patching, except as noted in "AIA Document A201" and "Supplementary Conditions for Mechanical and Electrical Work."
8. Excavating and backfilling.
9. Providing louvers in doors.
10. Providing undercut doors.
12. Providing plenums other than sheet metal.
13. Providing flashing.
15. Providing equipment platforms.
16. Providing pipe heat tracing system.

1.3 QUALITY ASSURANCE

A. All equipment and accessories shall be the product of manufacturers regularly engaged in their manufacture. All items of a given type shall be the products of the same manufacturer.

B. Furnish all equipment and accessories new and free from defects.

C. All electrical equipment shall be listed by Underwriters' Laboratories, Inc. (UL) or bear UL labels.

D. Supply all equipment and accessories in complete compliance with and in accordance with the applicable standards listed in reference standards of this Section and with all applicable national, state and local codes.

1.4 FACILITY OPERATIONS REQUIREMENTS

A. Shop drawings product data, samples and certificates of compliance required by contract documents, "AIA Document 201" and "SUPPLEMENTARY CONDITIONS FOR MECHANICAL AND ELECTRICAL WORK."
B. Operating instructions, maintenance manuals and parts lists.
   1. Provide manufacturer's equipment brochures and service manuals consisting of the following:
      a. Descriptive literature for equipment and components.
      b. Model number and performance data.
      c. Installation and operating instructions.
      d. Maintenance and repair instructions.
      e. Recommended spare parts lists.

   2. Assemble manufacturers' equipment manuals in chronological order following the specifications' numbering system using heavy duty three ring binders.

   3. Submit valve tag chart.

   4. Submit field test reports including instrument set points and normal operating valves.

C. Warranties

1.5 PREPURCHASED EQUIPMENT

A. Assignment:
   1. Equipment has been pre-purchased by the owner for this project. The mechanical contractor, by bidding on this project, accepts assignment of the pre-purchased equipment described herein which shall be received, installed and put into operation by this mechanical contractor.

B. Coordination:
   1. Mechanical contractor shall provide coordination between installation of pre-purchased equipment and equipment that is not pre-purchased and furnished by this contractor. Mechanical contractor to obtain all submittals from pre-purchased equipment manufacturer and submit shop drawing as part of his work.

C. Delivery:
   1. Mechanical contractor shall accept delivery of pre-purchased equipment at a designated location and in accordance with the delivery schedule as directed by owner's representative. Bid shall indicate location of delivery.
D. Installation:
1. Mechanical contractor shall provide all labor for and schedule the installation of pre-purchased equipment in a timely manner, as directed by the general contractor or owner’s representative. Bid shall indicate location of delivery.

2. Provide miscellaneous appurtenances as required to make pre-purchased equipment a properly functioning part of the work of this trade.

3. Provide pre-purchased equipment installation in accordance with manufacturer’s recommendation and the contract documents.

4. Provide all tools and materials as required to provide a complete installation of all pre-purchased equipment.

E. Up Front Purchase of Equipment:
1. The Contractor shall submit a list of long lead time items that will affect the schedule of the project if not purchased immediately up front at the start of the project. The Mechanical Contractor shall submit proposed manufacturer and lead times for all project equipment at time of project award.

1.6 DESCRIPTION OF BID DOCUMENTS

A. Specifications, in general, describe quality and character of materials and equipment.

B. Drawings, in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation. Provide additional offsets, fittings, hangers, supports, valves, drains as required for construction and coordination with work of other trades.

C. Scaled and indicated dimensions are approximate and are for estimating purposes only. Before proceeding with work, check and verify all dimensions.

D. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.

E. Typical details, where shown on the drawings, apply to each and every item of the project where such items are applicable. Typical details are not repeated in full on the plans, and are diagrammatic only, but with the intention that such details shall be incorporated in full.
F. If any part of Specifications or Drawings appears unclear or contradictory, consult Architect and/or Engineer for interpretation and decision as early as possible during bidding period. Do not proceed with work without the Architect's and/or Engineer's decision.

1.7 DEFINITIONS

A. "Furnish" or "provide": to supply, install and make complete, safe, and operable, the particular work referred to unless specifically indicated otherwise.

B. "Install": to erect, mount and make complete with all related accessories.

C. "Supply": to purchase, procure, acquire, and deliver complete with related accessories.

D. "Work": includes labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.

E. "Piping": includes pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and all related accessories.

F. "Wiring": includes raceway, fittings, wire, boxes, and all related accessories.

G. "Concealed": not in view, installed in masonry or other construction, within furred spaces, double partitions, hung ceilings, trenches, crawl spaces, or enclosures.

H. "Exposed": in view, not installed underground or "concealed" as defined above.

I. "Indicated," "shown," or "noted": as indicated, shown or noted on drawings or specifications.

J. "Similar" or "equal": of base bid manufacturer, equal in quality, materials, weight, size, performance, design and efficiency of specified product, conforming with "Base Bid Manufacturers."

K. "Reviewed," "satisfactory," "accepted," or "directed": as reviewed, satisfactory, accepted, or directed by or to Architect and/or Engineer.

L. "Motor Controllers": includes manual or magnetic starters with or without switches, individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

M. "Control or Actuating Devices": includes automatic sensing and switching devices such as thermostats, pressure, float, flow, electro-pneumatic switches and electrodes controlling operation of equipment.
N. Provide for the following equipment or systems, as directed:
   1. 

O. Submit for review, samples, and components prior to construction of mock-up.

1.8 JOB CONDITIONS

A. Inspection of Site Conditions:
   1. Before starting work, visit the site and examine the conditions under which the work has to be performed. Report in writing any conditions which might adversely affect the work.
   2. Install new work and connect to existing work with minimum interference to existing facilities.
   3. Provide temporary shutdown of existing services at no additional charges and only with written consent of Owner. Schedule shutdowns not to interfere with normal operation of existing facilities.
   4. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
   5. Connect new work to existing work in neat and acceptable manner. Restore existing disturbed work to original condition.
   6. Perform the following work only after regular working hours:
      a. 

B. Removal and relocation of existing work.
   1. Disconnect, remove, or relocate HVAC material, equipment, and other work noted and required by alterations, modifications, or changes in existing construction.
   2. Provide new material and equipment required for relocated equipment.
   3. Plug or cap active piping or ductwork behind or below finish.
   4. Dispose of removed HVAC equipment as directed.

1.9 OR

1. Return removed HVAC equipment to Owner as directed.
B. Hazardous locations:
   1. Provide required material, equipment and installation applicable for hazardous location defined by codes.
   2. Provide material, equipment and installation as required for Class, Division and Group noted.

1.10 REFERENCE STANDARDS

   A. Published specifications, standards tests, or recommended methods of trade, industry or governmental organizations apply to work in all Sections as noted below:
      1. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers.
      2. AABC - Associated Air Balance Controls.
      4. ADC - Air Diffuser Council.
      5. NEMA - National Electrical Manufacturers' Association.
      7. ASME - American Society of Mechanical Engineers.
      11. UL - Underwriters' Laboratories, Inc.
      12. OSHA - Occupational Safety and Health Administration Regulations.

1.11 SUBMISSIONS:

   A. Provide all coordination drawings, ductwork and piping shop drawings in ‘AutoCad” format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.
B. If paper submissions are to be provided the following shall be adhered to.
   1. Submissions 11 in. X 17 in. or smaller: If the submission is a catalog cut, then the contractor shall submit one original and one copy. Otherwise, they shall submit two copies. The architect will forward the original and one copy (two copies when no original is received) to the engineer. All catalog cuts shall be complete.
   2. Submissions larger than 11 in. X 17 in.: submit two copies to the architect. The architect will forward to the engineer.

C. Indicate on each submission: project name and location, architect and engineer, item identification and approval stamp of prime contractor, subcontractor names and phone numbers, reference to the applicable design drawing or specification article, date and scale.

D. The work described in all shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job.

E. Each submitted shop drawing is to include a certification that all related job conditions have been checked and verified and that there are no conflicts.

F. All shop drawings are to be submitted to allow ample time for checking in advance of field requirements. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts shall be submitted as a package.

G. If submittals differ from the contract document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

1.12 AS-BUILTS AND EQUIPMENT OPERATION INSTRUCTIONS

A. Provide all coordination drawings, ductwork and piping shop drawings in Auto-Cad format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. On completion and acceptance of work, this contractor shall furnish written instructions, equipment manuals and demonstrate to the owner the proper operation and maintenance of all equipment and apparatus furnished under this contract.

C. The contractor shall give one copy of the instructions to the owner and one copy to the engineer.
D. Final “as-built” drawings indicating as installed conditions shall be provided to the architect and engineer after completion of the installation.

1.13 CLEARANCE FROM ELECTRICAL EQUIPMENT

A. Piping and ductwork is prohibited in electric and telephone rooms and closets, elevator machine rooms, and for installations over or within 5 ft of transformers, substations, switchboards, motor control centers, standby power plants, and motors.

B. Branch piping to equipment is acceptable when installed over or within 5 ft of motors.

1.14 DRIP PANS

A. Provide drip pans under piping when installation over or within 5 ft of electrical apparatus is unavoidable or in rooms containing electrical equipment. Pan shall be reinforced, properly supported and made watertight. Provide enclosed type for pressure piping. Extend 1-1/4 in. drain pipe from pan to spill over nearest floor drain or as indicated.

1.  Construction shall be 18 gauge galvanized sheet steel.

1.15 PRODUCT, DELIVERY, HANDLING AND STORAGE

A. Ship materials and equipment in crated sections of sizes to permit passing through available space, where required

B. Deliver equipment with protective crating and shrink-wrapped covering.

C. Receive and accept materials and equipment at the site, properly handle, house, and protect them from damage and the weather until installation. Replace equipment damaged in the course of handling without additional charge.

D. Store to prevent damage and protect from weather, dirt, fumes, water, and construction debris in clean dry space

E. Arrange for and provide storage space or area at the job site for all materials and equipment to be received and/or installed in this project

F. All exposed openings of equipment, piping and ductwork are to be covered

G. Handle according to manufacturer’s written rigging and installation instructions for unloading, transporting, and setting in final location

H. Protect units from physical damage. Leave factory shipping covers in place until installation
1.16 TEMPORARY HEAT

A. Temporary heat will be provided under General Construction Work.

1.17 ACCESSIBILITY

A. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made without written approval.

B. Group concealed valves, expansion joints, controls, dampers, and equipment requiring access, so as to be freely accessible through access doors.

C. Locate all above ceiling equipment, i.e. terminal units, ac units, for full maintenance access above the ceiling. Ensure that all equipment controllers and operators are located minimum 24 inches from any obstruction (walls, pipe, etc.). Provide a minimum 42 inch clearance (per NEC) for access to electrical panels. The architects furniture floor plan shall not block equipment access.

D.

1.18 SPECIAL TOOLS

A. Provide one set of any special tools required to operate, adjust, dismantle or repair equipment furnished under this Division for the Owner’s use at the completion of the work.

B. Provide one pressure grease gun with adapters for each type of grease required.

C. Provide one suitable tool case for special tools.

1.19 CUTTING AND PATCHING

A. Provide all carpentry, cutting and patching required for proper installation of materials and equipment specified. Do not cut or drill structural members without review by Architect and Structural Engineer.

1.20 UTILITY CONNECTIONS

A. Arrange for and pay costs for all specified utilities including the following:
   1. Connection to utility company mains.
   2. Payment of service charges.
3. Provision for temporary utilities.

4. Connect in accordance with authority having jurisdiction.

1.21 PROTECTION OF MATERIALS

A. Protect from damage, water, dust, etc., materials, equipment and apparatus provided under this trade, both in storage and installed.
1.22 SUBSTITUTIONS

A. No substitute material or manufacturer of equipment shall be permitted without a formal written submittal to the engineer which includes all dimensional, performance and material specifications and is approved in writing by the engineer. Any changes in layout or design brought about by the use of a substitution shall be submitted to the engineer fully designed for review in conjunction with the submittal of the alternate. Any substitution must be submitted with an explanation why a substitution is being utilized. If the substitute is being utilized for financial reasons, the associated credit must be simultaneously submitted. Final acceptance or rejection of any substitution is subject to the owner's review.

1.23 STANDARDS:

A. If any item in the specification, as furnished by the contractor, is manufactured in a location which does not certify ASME/ANSI standards, the contractor is to pay the Owner for ALL expenses incurred by the Owner for an outside testing company to confirm such compliance.

1.24 COORDINATION

A. Arrange for pipe spaces, duct spaces, space for equipment, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

D. Provide coordination drawing for all areas of the work. The drawings shall have the following qualities:
   1. Minimum 3/8” scale
   2. Clearly show all the work for each trade including, but not limited to hangers, valves, dampers, actuators, access doors and service access requirements for all items.
   3. Indicate bottom elevations of all ductwork, electrical conduit, raceways, cable trays, control wiring and piping.
   4. Ductwork, piping, and conduit 3 inches and smaller may be shown in single line.
   5. Ductwork, piping, and conduit greater than 3 inches shall be shown in double line.
6. Color scheme:
   a. Architectural and structural background: Light grey.
   b. Ductwork: Black.
   c. Equipment and pads: Purple.
   d. HVAC piping and equipment: Green.
   e. Electrical conduits and equipment: Blue.
   f. Plumbing: Orange.
   g. Fire protection: Red.
   h. Control wiring: Pink.

1.25 GUARANTEE

A. In accordance with General Conditions (AIA Document 201) & Supplementary Conditions for Mechanical & Electrical Work.

B. The Contractor shall furnish a written guarantee to replace or repair promptly and assume responsibility for all expenses incurred for any workmanship and equipment in which defects develop within one year form the date of final certificate for payment and/or from date or actual use of equipment or occupancy of spaces by Owner included under the various parts of work, whichever date is earlier. This work shall be done as directed by the Owner. This guarantee shall also provide that where defects occur, the Contractor will assume responsibility for all expenses incurred in repairing and replacing work of other trades affected by defects, repairs or replacements in equipment supplied by the Contractor.

1.26 PERMITS AND FEES

A. In accordance with General Conditions (AIA Document 201) & Supplementary Conditions for Mechanical & Electrical Work.

B. The Contractor shall give necessary notice, file drawings and specifications with the department having jurisdiction, obtain permits or licenses necessary to carry out this work and pay all fees therefore. The Contractor shall arrange for inspection and test of any or all parts of the work if so required by authorities and pay all charges for same. The Contractor shall
pay all costs for, furnish to the Owner before final billing, all certificates necessary as evidence that the work installed conforms with all regulations where they apply to this work.

C. This contractor shall prepare or hire the necessary consultants to prepare and file all plans, calculation, forms, etc. required for filing with all agencies required for this work including but not limited to The DEP (Department of Environmental Protection), DEC (Department of Environmental Conservation, Bureau of Air Resources, EPA Environmental protection Agency, FDNY, etc..

1.27 SPECIAL / CONTROLLED INSPECTION- NEW YORK CITY PROJECTS

A. Special inspection shall be provided by the owner. This contractor shall provide all required services to accomplish these inspections.

1.28 INSPECTIONS / TESTING

A. Independent testing and inspections shall be provided by this contractor who shall hire the inspector or testing agency

1.29 SERVICE AND WARRANTY (MAINTENANCE CONTRACT

A. This contract shall provide a full year service and warranty of all mechanical components and systems with add alternate prices for years 2, 3 and 4 following this first year. At the time of acceptance of project, the tenant or owner’s representative will decide to accept which alternate, if any.

1.30 RIGGING

A. This contractor shall provide all required rigging, hoisting and bracing to install the equipment as indicated on the plans. This work shall be performed by an insured certified licensed rigging company that is experienced in rigging equipment of the type indicated for the areas shown on the construction documents. This contractor shall submit rigging plans for approval prior to proceeding with the work.

B. All permits required from the authorities and agencies involved to perform the rigging are the responsibilities of this contractor.

C. All structural supports, modifications or additions are to be submitted to the structural engineer for approval prior to proceeding with the work. All supplemental structural supports, elevator charges/modifications, bracing and protection required for the rig is the responsibility of this contractor

D. The rigging contractor shall hire and pay for all charges and services of the building elevator contractor for the rigging of the equipment.
1.31 HOT (WET) TAPS:

A. Provide new hot (wet) tap connections into piping systems as indicated on the plans.

B. Provide all required equipment and materials such as a tapping machine, welding machine, full ported valve and a pressure containing fitting. Valve and pressure fitting to be rated for the working pressure of the piping system.

C. Hot tap to be performed by a qualified contractor who is specialized in performing this type of work. Contractors name shall be submitted to the owner, owner’s representative, building management and engineer for approval prior to commencing work.

D. Hot (wet) tap coupon is to be turned over to building management.

1.32 DRAIN DOWN FOR NEW PIPING CONNECTION INTO EXISTING:

A. Contractor to obtain schedule and coordinate with building management for system drain down and connection into existing building piping. All costs associated with drain down are to be included as part of bid.

1.33 REUSE OF EXISTING EQUIPMENT AND TESTING

A. Refer to “TESTING, ADJUSTING AND BALANCING FOR HVAC” for all requirements and testing.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

A. Base bid on materials or equipment are specified by name of manufacturer, brand or trade name and catalog reference.

B. The choice will be optional with bidder where two or more manufacturers are named.

C. The following are base bid manufacturers for items under this Section:


2. Inserts: F and S Mfg Co., Fee and Mason and Grinnell.


5. Gratings: Irving Grating IKG Industries and Ryerson - Inland Steel Co.

2.2 INSERTS AND SUPPORTS

A. Support all HVAC work from building construction by providing inserts, beam clamps, steel fishplates (in concrete fill only), and acceptable brackets. Submit all methods for review.

B. Provide trapeze hangers of bolted angles or channels for grouped lines and services.

C. Provide additional framing where building construction is inadequate. Submit for review.

D. Inserts shall be steel, slotted type and factory-painted.
   1. Single rod shall be similar to Grinnell Fig. 281.
   2. Multi-rod shall be similar to Fee & Mason Series 9000 with end caps and closure strips.
   3. Clip form nails flush with inserts.
   4. Maximum loading including pipe, contents and covering shall not exceed 75 percent of rated insert capability.

E. Supports from steel decks:
   1. Pipes:
      b. Hanger spacing: maximum — centers.
   2. Ductwork:

2.3 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS:

A. Furnish supplementary steel, channels and supports required for proper installation, mounting and support of HVAC work.
B. Connect supplementary steel and channels firmly to building construction in an acceptable manner.

C. Determine type and size of supporting channels and supplementary steel. Supplementary steel and channels shall be of sufficient strength and size to allow only a minimum deflection in conformance with manufacturer’s requirements of loading.

D. Install supplementary steel and channels in a neat and workmanlike manner parallel to walls, floors, and ceiling construction.

E. All supplementary steel, channels, supports shall be submitted to Structural Engineer for review.

2.4 EXPANSION ANCHORS

A. Provide smooth wall, non-self-drilling internal plug expansion type anchors constructed of AISC 12L14 steel and zinc plated in accordance with Fed. Spec. QQ-A-325 Type 1, Class 3.

B. Do not exceed 1/4 of average valves for a specific anchor size using 2000 psig (13,800 kpa) concrete only, for maximum working load.

C. Provide spacing and install anchors in accordance with manufacturer’s recommendations.

2.5 ACCESS DOORS

A. This contractor shall submit to the architect for approval a plan indicating the size (minimum 18" x 18") and location of all access doors required for operation and maintenance of all concealed equipment, devices, valves, dampers and controls. Contractor shall arrange for furnishing and installation of all access doors in finished construction and include costs in the bid.

B. Supply access doors for all concealed HVAC items in inaccessible walls and ceilings for complete access, using a minimum door size of 12 in. x 12 in. for installation under the General Construction Work. Locating and setting shall be performed after review.

C. Flush type access doors shall be similar to Karp Type DSC-211 with No. 13 USSG steel doors and trim and No. 16 USSG steel frame, metal wings for keying into construction, concealed hinges and screwdriver operated stainless steel cam lock. Provide lift off type access doors, similar to Karp Type DSC-212, where door cannot swing open.
D. In acoustic tile ceilings, factory finished white access doors shall be similar to Karp Type DSC-210, with No. 13 USSG steel frame, No. 16 USSG steel pan door suitable for receiving tile thickness and hinges that are not visible when door is closed. Access door shall have screwdriver operated stainless steel cam locks finishing flush with tile with a minimum of 2 per door.

E. In plaster ceilings recessed access doors shall be similar to Karp DSC-210-PL, with recess to receive plaster.

F. In fire rated construction provide fire rated access doors, similar to Karp KRP-150-FR, in accordance with applicable code requirements.

G. Access doors shall have one coat of shop-painted zinc chromate primer.

2.6 ACCESS TILE IDENTIFICATION:

A. In removable ceiling tiles, provide buttons, tabs, and markers to identify location of concealed work. Submit for review.

2.7 ACCESS PLATFORMS:

A. Provide access platforms for equipment, where indicated or required by authorities having jurisdiction, in accordance with OSHA regulations and indicate on shop drawings, details of construction and method of attachment.

B. Provide removable gratings, toe-plates, and guard rails suitable for a minimum 100 pounds per sq ft floor loading.

C. Provide supports riveted or welded structural steel cross-braced on four sides and welded to baseplates for anchor bolting to concrete piers.

D. Gratings shall be similar to:
   1. Steel: Irving "x-bar."

2.8 EQUIPMENT PLATFORMS

A. Equipment platforms will be provided under General Construction Work.

B. Provide equipment platforms, where indicated or required by authorities having jurisdiction, in accordance with OSHA regulations and as indicated. On shop drawings, show details of construction and method of attachment. Submit for review.
C. Equipment platform shall be supported from floor. Platform shall be riveted or welded structural steel frame with intermediate framing. Corners shall be reinforced with gusset plates. Baseplate shall be minimum 10 USSG steel plate riveted or welded to frame. Supports shall be riveted or welded structural steel, cross-braced on four (4) sides and welded to baseplate for anchor bolting to concrete piers. Submit for review.

D. Fasten vibration isolation bases as noted. Submit for review.

E. Submit shop drawings with details of construction and method of attachment.

2.9 LADDERS

A. Provide 18 in. wide properly supported, galvanized structural steel ladders designed in accordance with OSHA regulations with 2-1/2 in. x 2-1/2 in. side rails and 3/4 in. diameter rungs installed 12 in. on center.

B. Provide shaft gratings suitable for minimum of 100 pounds per sq ft floor loading.

C. Support on structural steel members and indicate on shop drawings, details of construction and method of attachment.

D. Trench covers and frames will be provided under General Construction Work.

E. Covers:
   1. Provide 3 ft long, 1/4 in. thick galvanized checkered steel covers with flush drop-type lift handles and means for securing to frame for easy removal.
   2. Provide 3 ft long, 1/4 in. thick galvanized expanded and perforated steel covers with flush drop-type lift handles and means for securing to frame for easy removal.

F. Provide 2 in. x 2 in. x 1/4 in. galvanized welded angle iron frame with welded stops and lugs for anchoring into concrete.

G. Supply trench covers and frames for installation under General Construction Work.

2.10 GUARD RAILINGS

A. Provide guards and railings as indicated and/or as required by OSHA and authorities having jurisdiction.

B. Provide removable type guards with clearances for motor adjustments, for belt driven and rotating equipment, with No. 18 USSG steel frames and No. 20 USSG galvanized...
perforated steel fronts with covered test openings to permit rpm readings without removal. Provide galvanized steel angle or channel supports braced to maintain clearances of moving parts.

C. Provide removable type railings constructed of 1-1/4 in. pipe and rail fittings.

2.11 TAGS:

A. Provide 2 in. round valve tags on all valves and controls of No. 18 BS gauge aluminum with stamped numbers and letters filled in with black paint.

B. Indicate identifying number and system letter on tags, and fasten by heavy aluminum or brass hooks or chains.

C. Tags shall be similar to Seton Name Plate Corporation.

2.12 NOTE: FOR EXISTING BUILDINGS

A. Supplement numbering and lettering of valve tags of existing building.

2.13 CHARTS

A. Provide valve tag chart indicating valve number, system, type, size, location and function for all valves.

B. Mount in aluminum frame and glass.

C. Letter and number valves and controls to correspond with designations on metal tags.

D. Fasten charts permanently in locations, as directed, with four brass screws.

E. Supplement numbering and lettering of charts of existing building.

2.14 NAMEPLATES

A. Provide nameplates with inscriptions, subject to review, indicating equipment and voltage. Fasten with epoxy cement or chrome plated screws. Nameplate shall be black Lamicoid sheet.

B. Provide nameplates for gauges, meters, instruments, control devices, pilot lamps, transmitters, motor controllers and panel mounted equipment.

2.15 PAINTING

A. General:
1. Provide labor, materials, and equipment necessary for field prime painting. Protect flooring and equipment with drop cloths and store paint and materials in a location where directed. Wire brush and remove all oil, dirt, rust and grease before applying paint.

2. Paint all exposed, un-insulated, non-galvanized sheet metal, other than stainless steel and aluminum, with two coats of aluminum paint or alkyd paint of a color as directed.

3. Paint all exposed, un-insulated, galvanized, aluminum and stainless steel sheet metal in finished spaces, including mechanical equipment rooms, with one coat of galvanized iron primers and two coats of alkyd oil paint.

4. Paint insulated piping and equipment covering with one coat of primer sealer and two coats of alkyd oil paint of a color as directed.

5. Factory or field apply one coat of heat resisting paint for steel pipe and finned tube radiation.

6. Paint exposed steel and metal work not furnished with factory-painted finish, structural steel piping support and un-insulated piping with two coats of alkyd oil paint of a color as directed.

7. Paint the following spaces under this contract:
   a. Mechanical Equipment rooms.
   b. Boiler Plant.
   c. Refrigeration Plant.
   d. Steam Pressure Reducing Valve Room.
   e. Steam Metering Room.
   f. Emergency Generator Plant.

8. Apply zinc chromate primer for black steel piping, cast iron piping (except underground), steel and iron work and steel tanks before insulation.

9. Dip in zinc chromate primer, uncoated hangers, supports, rods and inserts.
B. Coordinate color of painting to be provided under General Construction Work.

C. Supply and deliver, in original sealed containers, paint of the best grade for its purpose of colors, as selected, and apply in accordance with manufacturer’s instructions.

D. Finish painting:
   1. Provide finish painting for piping continuously painted in all exposed areas consisting of two finished coats of high gloss medium or long alkyd paint over prime coat of a color shade as accepted after submittal.

   2. Utilize color schedule as follows based on Sherwin Williams, name, figure numbers and finish.

      a. Chilled water piping and equipment – PALE BLUE, full glass.
      b. Condenser water piping – PALE GREEN, full glass.
      c. High pressure steam – ORANGE, full glass.
      d. Medium pressure steam – FERRITE YELLOW, full glass.
      e. Low pressure steam – LIGHT YELLOW, full glass.
      f. Low pressure condensate – IVORY, full glass.
      g. Hot water, pumped condensate and equipment – MAGENTA full glass.
      h. Chemical feed piping and equipment – DARK BLUE, full glass.
      i. Refrigeration machines and refrigerant piping – BRIGHT BLUE, full glass.
      j. Supply ductwork and fans – SILVER GRAY, full glass.
      k. Control panels – SLATE GRAY, full glass.
      l. Exhaust and return ductwork and fans – STEEL GRAY, full glass.
      m. Fire detection and alarm conduit, fire stand pipe, sprinkler piping – VERMILLION, full glass.
      n. Compressed air piping and equipment – LIGHT GRAY, full glass.
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o. Vent and relief piping – RICH BROWN, full glass.
q. Fuel and diesel oil – BLACK, full glass.
r. High temperature water – ORANGE, full glass.
s. Softened water, dealkalizers, softeners, brine tanks – MEDIUM GREEN, full glass.
t. Expansion tanks – same color as piping system.
u. City water – LIGHT GREEN, full glass.

3. Place unlisted piping, ductwork or equipment in one of the following classifications and color coded shades as accepted. This corresponds to colors of ANSI A13.1, (Scheme for identification of piping systems).

b. Yellow or Orange for dangerous materials.
c. Green or blue for safe materials.
d. Dark Blue or Purple for extra valuable materials.
e. Gray for general equipment.

4. Shades shall be consistent throughout the project.

5. Coat valve, strainer or other appurtenances operating at over 220 o F where bare metal is exposed with Silicone Alkyd Aluminum, 71S30.

E. Paint interior of ductwork as far back as visible from outside, flat black.

F. Apply factory prime coat for pumps, fans, motors, equipment, registers, diffusers, and grilles.

G. Apply on machinery, one shop coat of metal primer and two finish coats of gray engine enamel.
H. Apply on control valve handles, one coat of paint of color as selected.

I. Paint fire dampers with prime coat and second coat of corrosion inhibitive paint.

J. Spot prime coat marred surface of prime coated equipment and piping to match adjacent
2.16 FIELD QUALITY CONTROL

A. Perform tests as noted, and in the presence of Architect and/or Engineer and authorities having jurisdiction.

B. Provide required labor, material, equipment, and connections necessary for tests and submit results for review.

C. Repair or replace defective work and pay for restoring or replacing damaged work due to tests, as directed.
   1. Licensed Professional Engineer shall be hired by the mechanical contractor for Controlled Inspection.

D. The following services are available from Owner as directed.
   1. ————.

E. Tests and instruction: Refer to specification Section ——.

END OF SECTION
COMMON WORK RESULTS FOR HVAC
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
7. Grout.
8. HVAC demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.2 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code-Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

C. Welding: Before proceeding, submit the following for review and approval;

1. Proposed procedure conforming to latest revision of:
   a. ANSI/ASME B31.1, pressure piping chapter V.
   b. ANSI/ASME B31.9, Building Services Piping
   c. ANSI 249.1 Safety in Welding and Cutting
   d. List of welders qualified per section IX of ASME. Boiler and Pressure Vessel Code including, but not limited to, the following information:
      1) Welder’s name
      2) Welder’s Social Security Number
      3) Employer’s name
      4) Name of testing laboratory
      5) Procedure tested for including, but not limited to, the following:
         a) Date of test
         b) Wall thickness
         c) Base metal material
         d) Electrode
         e) Position
      6) Type of test performed
7) Result of test
8) Welder’s identification symbol
9) Sample of each identification device
10) Certify that each welder has either worked in the procedure or successfully tested in the procedure within the past six months
11) WPQ
12) PQR
13) WPS

2. No reports from any welding inspection agency shall be accepted unless each agency has first requested and obtained qualifications from the office in accordance with rule 16-1 of the Board of Standards and Appeals welding rule.

D. Brazing: Before proceeding, submit the following for review and approval;

1. Proposal procedure conforming to latest revision of:
   a. Section IX, ASME boiler and pressure vessel code, welding and brazing qualifications.
   b. ANSI/AWS B2.2 Standard for Brazing Procedure and Performance Qualification

2. List of brazers qualified per section IX of ASME. Boiler and Pressure Vessel Code including, but not limited to, the following information:

   1) Brazer’s name
   2) Brazer’s Social Security Number
   3) Employer’s name
   4) Name of testing laboratory
   5) Procedure tested for including, but not limited to, the following:
      a) Date of test
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b) Wall thickness
c) Base metal material
d) Brazing filler material
e) Position

6) Type of test performed
7) Result of test
8) Brazer’s identification symbol
9) Sample of each identification device
10) Certify that each Brazer has either worked in the procedure or successfully tested in the procedure within the past six months
11) BPQ
12) PQR
13) BPS

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Crimp or press fittings shall not be used.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Eclipse, Inc.
   d. Epco Sales, Inc.
   g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.
2.5  MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
   e. Thunderline Link-seal

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6  SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
   1. Under deck Clamp: Clamping ring with set screws.

2.7  ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: set screw or spring clips and chrome-plated finish.

C. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

E. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.
2.8 GROUT

A. General Purpose Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 14000 / 19000-psi, 36 hours @ 70 degrees compressive strength.
3. Packaging: factory packaged for field mixing.


1. Characteristics: Two to Three-component, highly flowable, epoxy-based grout that produces high performance strength plus chemical inertness and excellent bonding properties.
2. Design Mix: ASTM-C 579, 14,000 / 19,000 psi, 36 hours @ 72 degree F compressive strength.
4. Products: Chocfast by ITW Philadelphia resins, ESCOWELD or approved equal.

2.9 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
      e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
      f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions 16 Gauge
         1) Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Refer to Division 07 Section "Penetration Fire-stopping" for materials.

Q. Verify final equipment locations for roughing-in.
R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

2.10 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
   3. Threaded fittings not allowed in glycol system.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Crimp or press fittings shall not be used.

2.11 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

2.12 DUCT SYSTEMS – COMMON REQUIREMENTS

A. Install ductwork according to the following requirements and Division 15 Sections specifying metal ducts, casings, duct accessories and related components.
B. Drawing plans, schematics and diagram indicate general location and arrangement of duct systems. Indicated locations and arrangements were used to size ducts and calculate friction loss, expansion, fan sizing and other design considerations. Install ductwork as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
D. Install ductwork indicated to be exposed and ductwork in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install ductwork above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install ductwork to permit servicing of C.V. boxes, VAV boxes, dampers, actuators, filters, humidifiers, and as required.
G. Install with indicated horizontal and vertical offset.
H. Install ductwork free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install ductwork to allow application of insulation.
K. Select system components with pressure class equal to or greater than system operating pressure.
2.13 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 230500
COMMON MOTOR REQUIREMENTS FOR
HVAC EQUIPMENT
SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 The mechanical contractor is to provide motor, motor controllers and vfd’s. The mechanical contractor to install motor, motor controllers and vfd’s. The electrical contractor is to wire all motors, motor controllers and vfd’s.

1.3 QUALITY ASSURANCE

A. Comply with NEMA MG 1 Standard.

1.4 FACILITY OPERATIONS REQUIREMENTS

1. Motor dimensions, wiring and efficiency data.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Baldor, General Electric, Gould, Louis Allis, Reliance.

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.
C. Comply with IEEE 841 for severe-duty motors.

D. Approved Manufacturers are: e

E. All motors shall be of same manufacturers.

F. Select highest efficiency available (minimum 95%).

G. Inverter duty motors to be standard
   1. Motors shall be inverter duty with compact winding.

H. Solid State Overload Motors with overload protection shall be used for small motors

I. NEMA enclosure shall be used if available with equipment and space allows. If not, IEC enclosure is acceptable

2.3 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.4 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

F. Bearings: Permanently lubricated bearings shall be ball or roller type and Regreasable type shall be shielded antifriction ball bearings suitable for radial and thrust loading with pressure type lubricating fittings similar to alemlite and Keystone extended to accessible location.

G. Temperature Rise: Class B temperature rise.

H. Insulation: Class F.

I. Code Letter Designation:

J. Motors 15 HP and Larger: NEMA starting Code F or Code G.

K. Motors Smaller than 15 HP: Manufacturer’s standard starting characteristic.

L. Enclosure Material and Type: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T. Indoor motors shall be open drip proof type and outdoor motors shall be TEFC weatherproof type.

M. Electrical Heaters: Provide for motors located outdoors and in areas where condenation can occur.

N. Slide Base and Alignment: Provide foundation slide base and double jack screw alignment for belt-driven motors.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: [Ratings, characteristics, and features coordinated with and approved by controller manufacturer.]

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: (Minimum 95%) Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.6 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.7 MOTOR INSTALLATION - COMMON REQUIREMENTS

A. Install motors to facilitate service, maintenance, and repair or replacement of components with minimum interference to other installations.

B. Coordinate large motor installation with field conditions. This contractor shall provide all required rigging, hoisting and bracing to install the equipment as indicated on the plans.

END OF SECTION
ENCLOSED CONTROLLERS
SECTION 230514 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.
   2. Reduced-voltage controllers.
   3. Multispeed controllers.

B. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

C. Select horsepower rating of controllers to suit motor controlled.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed controllers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Danfoss Inc.; Danfoss Electronic Drives Div.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Siemens/Furnas Controls.
6. Square D.
2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 30 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.


2.3 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.


C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.
D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, poly-phase, medium induction motors.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:
   a. Control power available.
   b. Controller on.
   c. Overload trip.
   d. Loss of phase.
   e. Shorted silicon-controlled rectifier.
4. Motor running contactor operating automatically when full voltage is applied to motor.

2.4 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.5 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated. Provide terminals with copper to copper conductors.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty with digital readout in hours.
   1. Ammeter: Output current, with current sensors rated to suit application.
   2. Voltmeter: Output voltage.
   3. Frequency Meter: Output frequency.

F. Multifunction Digital-Metering Monitor: Listed and labeled by an NRTL acceptable to authorities having jurisdiction, microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
   2. Switch-selectable digital display of the following:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Three-Phase Real Power: Plus or minus 2 percent.
      e. Three-Phase Reactive Power: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
      i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
   3. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.

H. Current-Sensing, Phase-Failure Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

I. Provide HOA (Hand-Off-Auto) switches for all interlocked equipment. Provide minimum (2) NC and NO auxiliary contacts. Provide control transformers.

J. Fuses shall be similar to Bussman: Fusetron.

2.7 FACTORY FINISHES

A. Finish: Manufacturer’s standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

END OF SECTION 230514
VARIABLE FREQUENCY MOTOR CONTROLLERS
SECTION 230515 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY
THIS SECTION INCLUDES

1. Solid state, PWM VFCs for control of three phase squirrel cage induction motors.
2. Disconnect switches are to be provided by the electrical contractor if not integral with equipment.
3. Provide enclosures for VFD’s suitable for operating environment.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.
G. Field Quality Control:

Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

Setup drive set points to lock out operation at frequencies that may provide mechanical resonance.

Manufacturer’s Field Service: Engage a factory-authorized service representative to perform the following:

3. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
4. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
5. Report results in writing.
6. Service station shall be located within 100 miles of job site and shall be available upon a 24-hour basis.

Perform the following field tests and inspections and prepare test reports:

7. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
8. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of VFC include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights and manufacturer’s technical data on features, performance, electrical ratings, characteristics and finishes.

B. Shop Drawings: For each VFC.
1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit’s type and details.
   b. Nameplate legends.
   c. Short-circuit current rating of integrated unit.
   d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that VFCs, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."*

   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For manufacturer and testing agency.

F. Factory and Field quality-control test reports.
G. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFCs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:


2.2 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 40 deg C.
2. Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical service without Construction Manager's written permission.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

2.3 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.
   3. One of each printed circuit board provided.
   4. One of each inverter power semi-conductor for each rating supplied on the project.

2.4 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

   1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Confirm VFD rated amperage with motor amperage to confirm compatibility.

D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
E. Unit Operating Requirements:

1. Input ac voltage tolerance of 208 V, plus or minus 5 or 480 V, plus or minus 10 percent.
2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

F. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

G. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

H. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter over-temperature, overload, and overcurrent trips.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
7. Reverse-phase protection.
8. Short-circuit protection.
I. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

J. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

K. Power- Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Input Line Conditioning: Integral input 5% impedance line reactors. Limit harmonics to maximum 5% THD.

O. VFC Output Filtering: For long cable lengths from VFC to motor.

P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.


R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

11. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

12. Pneumatic Input Signal Interface: 3 to 15 psig.

13. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.

14. Output Signal Interface:
   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).

15. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
Variable Frequency Motor Controllers

b. Set-point speed reached.
c. Fault and warning indication (over-temperature or overcurrent).
d. PID high- or low-speed limits reached.

S. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multi-drop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

T. Bypass Controller: NEMA ICS 2, full-voltage, non-reversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

1. Provide Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, poly-phase, medium induction motors for motors 75 horsepower and greater.

U. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

V. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault

W. Provide five adjustable set points to lock out operation at frequencies that may provide mechanical resonance.

X. Provide terminal block connections for fan shutdown and reset from the building fire alarm system.

2.5 ENCLOSURES

A. NEMA 4 ventilated freestanding enclosure for motor horsepower listed on the design drawings. Coordinate final motor hp with fan/pump/equipment manufacturer.

2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   7. Motor output voltage (V).

F. Interlock terminal strip
   1. Provide a separate terminal strip for connection of freeze, fire, smoke and all dampers contacts and external start command. All external safety interlocks shall remain fully functional whether the system is in hand, auto, or bypass modes. The remote start/stop contact shall operate in auto and bypass modes.

G. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

2.7 FACTORY FINISHES

A. Finish: Manufacturer’s standard paint applied to factory-assembled and -tested VFCs before shipping.

END OF SECTION 230515
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-bellows expansion joints.
2. Expansion compensators.
3. Rubber expansion joints.
5. Packed slip expansion joints.
6. Flexible ball joints.
7. Pipe bends and loops.
8. Alignment guides and anchors.

1.2 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for expansion fittings and loops by a qualified professional engineer

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of expansion fittings and loops that are similar to those indicated for this Project in material, design, and extent.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated.
B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer’s number, size, material, pressure rating, end connections, and location for each expansion joint.
5. Coordination:
   a. Coordinate the location of all anchors, guides and expansion devices with the structural engineer.
   b. Submit details for attachment to the building structure to the structural engineer including all loads and supplemental steel.
   c. Coordinate the location of items in this section with access requirements for equipment, valves, dampers, as required for work in other sections, and as indicated on the drawings.

C. Welding certificates.

D. Factory quality control and test reports

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

F. Warranty

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
Expansion Fittings and Loops for HVAC Piping

1. Adsco Manufacturing, LLC.
2. Badger Industries.
3. Hyspan Precision Products, Inc.
4. Metraflex, Inc.

2. Metal-Bellows Expansion Joints for Copper Piping: Single- or multiple ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.


5. Minimum Pressure Rating: 175 psig unless otherwise indicated.

6. Configuration Single- or double-bellows type with base, unless otherwise indicated.

7. End Connections: Flanged

B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, antitorque device, and removable end clip for positioning.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adsco Manufacturing, LLC.
   b. Hyspan Precision Products, Inc.
   c. Metraflex, Inc.

2. Minimum Pressure Rating: 175 psig, unless otherwise indicated.

3. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.


5. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint.


7. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged or threaded

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. General Rubber Corp.
   d. Metraflex, Inc.
   e. Vibration Mountings & Controls, Inc.

2. Arch Type Single or multiple arches.

3. Spherical Type: Single or multiplespheres.
   a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
   b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F. Retain only those materials in first subparagraph below that are required. Indicate materials on Drawings if more than one is required. See Evaluations for discussion about rubber materials.

4. Material: EPDM

D. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flexicraft Industries.
   b. Metraflex, Inc.
2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections.
   a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
   b. NPS 2-1/2 to NPS 4 Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

3. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections.
   a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
   b. NPS 2-1/2 to NPS 4 Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

4. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
   a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
   b. NPS 2-1/2 to NPS 6 Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
   c. NPS 8 to NPS 12 Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.

5. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
   a. NPS 2 and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
   b. NPS 2-1/2 to NPS 6 Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
   c. NPS 8 and Larger: Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
E. Packed Slip Expansion Joints: ASTM F 1007, carbon-steel, packing type designed for repacking under pressure and pressure rated for 250 psig at 400 deg F minimum. Include asbestos-free PTFE packing, compound limit stops, and drip connection if used for steam piping.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adsco Manufacturing, LLC. Type RJ
   b. Advanced Thermal Systems, Inc. Thermal Pak-Type TP2
   c. Hyspan Precision Products, Inc.

2. Configuration: Single- and double-joint class with base, unless otherwise indicated.

3. End Connections: Flanged or weld ends to match piping system.

4. Provide limit stops, capable of holding against full internal thrust.

5. Packing: Provide self-lubricating asbestos-free polytetrafluoroethylene or asbestos-free reinforced teflon type, which can be injected under full line pressure, contained by minimum of 3 teflon non-asbestos rings at each side.

6. Provide joints body of weldable quality carbon steel, ASTM 53 grade B seamless pipe with drip connection if used for steam service.

7. Slip requirements: Provide ASTM A 53 grade B seamless pipe up to and including 12 inch: Schedule 80 and 16 inch through 24 inch: Schedule 60.
   a. Provide wall thickness after machining not reduced more than 1/8 inch.
   b. Provide double layer of chrome plating with minimum thickness 0.001 inch each after buffing. First layer: crack-free hard chrome; second layer: standard hard chrome.

8. Provide welded steel packing cylinder with internal acme thread and male threaded plunger with cylinder welded directly to stuffing box. Minimum number of packing cylinders as follows:

<table>
<thead>
<tr>
<th>Expansion Joint Size</th>
<th>Number of Packing Cylinders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch thru 4 inch</td>
<td>1</td>
</tr>
</tbody>
</table>
Expansion Fittings and Loops for HVAC Piping

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Expansion Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 inch and 6 inch</td>
<td>3</td>
</tr>
<tr>
<td>8 inch and 10 inch</td>
<td>4</td>
</tr>
<tr>
<td>12 inch and 14 inch</td>
<td>5</td>
</tr>
<tr>
<td>16 inch and 18 inch</td>
<td>6</td>
</tr>
<tr>
<td>20 inch and 24 inch</td>
<td>8</td>
</tr>
</tbody>
</table>

9. Pressure ratings:
   a. High pressure steam, high pressure condensate, high temperature water: 150 lb.
   b. High pressure steam, high pressure condensate, high temperature water: 300 lb.
   c. High pressure steam, high pressure condensate, high temperature water: 400 lb.
   d. Pumped condensate return: 150 lb.
   e. Pumped condensate return: 300 lb.

10. Provide all welding in accordance with Section IX of ASME Boiler and Pressure Vessel Code.

11. All welds for 300 lb. and 400 lb. joints shall be subjected to complete radiographic examination. No liquid or dye penetrant indication will be acceptable. Examination shall be as per requirements of Section V of ASME Boiler and Pressure Vessel Code.

F. Flexible Ball Joints: Carbon-steel assembly with asbestos-free composition packing, designed for 360-degree rotation and angular deflection, and 250 psig at 400 deg F minimum pressure rating; complying with ASME Boiler and Pressure Vessel Code: Section II, "Materials," and with ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.

1. Angular Deflection for NPS 6 and Smaller: 30-degree minimum.
2. Angular Deflection for NPS 8 and Larger: 15-degree minimum.
3. End Connections for NPS 2 and Smaller: Threaded.
4. End Connections for NPS 2-1/2 and Larger: Flanged.
5. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advanced Thermal Systems, Inc.
   b. Hyspan Precision Products, Inc.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adsco Manufacturing, LLC.
   b. Advanced Thermal Systems, Inc.
   c. B-Line systems, Inc.
   d. Grinnell Corp.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.
B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
C. Washers: ASTM F 844, steel, plain, flat washers.
D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

2. Expansion Plug: Zinc-coated steel.
E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink, nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

END OF SECTION 230516
METERS AND GAGES FOR HVAC PIPING
SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Gages.
   3. Test plugs.
   5. Thermal-energy meters.

B. The Contractor shall provide all devices, piping, valves, relays, end switches, control components, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operations for the specified meters and instrumentation and thereby provide a fully operational system.

1.2 QUALITY ASSURANCE

A. Product options: Drawings indicate size, profiles and connections for instrumentation and are based on the specific types and models indicated.

B. Electrical components, devices and accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

C. Standards: If any item in this specification as furnished by the contractor is manufactured in a location which does not certify ASME/ANSI standards, the contractor is to pay the owner for all expenses incurred by the owner for an outside testing company to confirm such compliances.

D. Pressure and temperature rating:
   1. Each meter and gauge shall be rated and suitable for the piping system that it is being installed in.
2. Refer to applicable piping section for service temperature and pressure rating of systems that meters and gauges are to be installed in.

3. Minimum upstream and downstream straight pipe diameters for meters shall be provided as per manufacturer’s published recommendations.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers gages flow meters and thermal-energy meters indicating manufacturer’s number, scale range, and location for each.

C. Factory quality control and test reports: For each type of thermometer gage flow meter and thermal-energy meter, signed by product manufacturer.

D. Operation and Maintenance Data: For flow meters and thermal-energy meters to include in emergency, operation, and maintenance manuals.

E. Warranty

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trerice, H. O. Co.

2. Weiss Instruments, Inc.

3. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

4. Miljoco Corporation

5. Mueller

6. Palmer

B. Case: Chrome-plated brass, 9 inches long.
C. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.

D. Window: Plastic.

E. Connector: Adjustable type.

F. Stem: Copper-plated steel, aluminum, or brass for thermo-well installation and of length to suit installation.

G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 DUCT-TYPE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Miljoco Corp.
   2. Mueller
   3. Palmer - Wahl Instruments Inc.
   4. Trerice, H. O. Co.
   5. Weiss Instruments, Inc.
   6. Weksler

B. Case: Die-cast aluminum 7 inches long.

C. Tube: Red or blue reading, organic filled, with magnifying lens.

D. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Window: plastic.

F. Connector: Adjustable type.

G. Stem: Metal, for installation in mounting bracket and of length to suit installation.
H. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.

I. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div
5. Mueller
6. Palmer

B. Miljoco Corporation Case: Dry Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

F. Pointer: Red or other dark-color metal.

G. Window: Plastic.

H. Ring: Stainless steel.

I. Connector: Adjustable type.

J. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermo-well installation and of length to suit installation.
K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.4 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
6. Mueller
7. Palmer

B. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

F. Pointer: Red or other dark-color metal.

G. Window: Plastic.

H. Ring: Stainless steel.

I. Connector: Back union type.

J. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermo-well installation and of length to suit installation.
2.5 BIMETALLIC-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Mueller
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
6. WIKA Instrument Corporation.

B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

C. Case: Dry type, stainless steel with 5-inch diameter.

D. Element: Bimetal coil.

E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

F. Pointer: Red or other dark-color metal.

G. Window: Plastic.

H. Ring: Stainless steel.

I. Connector: Adjustable angle type.

J. Stem: Metal, for thermo-well installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
2.6 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Miljoco Corp.
   2. Trerice, H. O. Co.
   3. Weiss Instruments, Inc.
   4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
   5. WIKA Instrument Corporation.

B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.7 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ashcroft
   2. Miljoco Corp.
   3. Trerice, H. O. Co.
   4. Weiss Instruments, Inc.
   5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Dry type for steam only, liquid-filled case type for all other services.

C. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
   1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.

4. Movement: Mechanical, with link to pressure element and connection to pointer.

5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

6. Pointer: Red or other dark-color metal.


9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.

10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.

11. Range for Fluids under Pressure: Two times operating pressure.

D. Remote-Mounting, Dial-Type Pressure Gages: ASME B40.100, indicating-dial type.

1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.

2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.

3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.

4. Movement: Mechanical, with link to pressure element and connection to pointer.

5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

6. Pointer: Red or other dark-color metal.


9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.

10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

E. Provide single gauge for pump installations mounted to a 4-port trumpet valve

F. Pressure-Gage Fittings:
   1. Valves: NPS 1/4 brass or stainless-steel needle type.
   2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
   3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trerice, H. O. Co.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.
   1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
   2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
   1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.

3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.

4. Carrying case shall have formed instrument padding.

2.9 WAFER-ORIFICE FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Inc.; ABB Instrumentation.

2. Badger Meter, Inc.; Industrial Div.

3. Bell & Gossett; ITT Industries.


5. Vortec

B. Description: Differential-pressure-design orifice insert for installation between pipe flanges; with calibrated flow-measuring element, separate flow meter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flow meter, and system fluid.

C. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.

D. Pressure Rating: 300 psig

E. Temperature Rating: 250 deg F

F. Range: Flow range of flow-measuring element and flow meter shall cover operating range of equipment or system served.

G. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flow meter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flow meter element.

1. Scale: Gallons per minute.
2. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.

H. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.
   1. Scale: Gallons per minute.
   2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

I. Permanent meters (electronic output): Provide electronic indicating pressure transmitter with a wall mounted display to perform square root computation and display.
   1. Provide differential pressure transmitter 2 wire, 4-20 MA output, range as required for project.
   2. Provide a digital display with NEMA 4X enclosure.
   3. The display panel requires 115 volt and the pressure transmitter requires ball valves and interconnecting piping rated for system pert pressure.

J. Operating Instructions: Include complete instructions with each flow meter.

2.10 VENTURI FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aeroquip
   2. Barco
   5. Foxboro
   7. Flexim
B. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flow meter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flow meter, and system fluid.

C. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data.

D. Pressure Rating: 250 psig

E. Temperature Rating: 250 deg F

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged or welded.

H. Range: Flow range of flow-measuring element and flow meter shall cover operating range of equipment or system served.

I. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
   1. Scale: Gallons per minute.
   2. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.

J. Portable Indicators: Differential-pressure type calibrated for connected flowmeter element and having two 12-foot hoses in carrying case.
   1. Scale: Gallons per minute.
   2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

K. Permanent meters (electronic output): Provide electronic indicating pressure transmitter with a wall mounted display to perform square root computation and display
   1. Provide differential pressure transmitter 2 wire, 4-20 MA output, range as required for project.
   2. Provide a digital display with NEMA 4X enclosure.
3. The display panel requires 115 volt and the pressure transmitter requires ball valves and interconnecting piping rated for system pert pressure.

L. Operating Instructions: Include complete instructions with each flow meter.

2.11 TURBINE FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Data Industrial Corp.
4. Fischer, George Inc.
5. ONICON Incorporated.

B. Description: Insertion type for inserting turbine into piping and measuring flow directly in gallons per minute.

C. Construction: Bronze or stainless-steel body; with plastic turbine or impeller and integral direct-reading scale.

D. Pressure Rating: 150 psig minimum.

E. Temperature Rating: 180 deg F minimum.

F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.

G. Accuracy: Plus or minus 2-1/2 percent.

2.12 VORTEX-SHEDDING FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Foxboro
4. MCO/Eastech, Inc.

B. Description: Inline type for installing between pipe flanges and measuring flow directly in gallons per minute.

C. Construction: Stainless-steel body; with integral transmitter and direct-reading scale.

D. Pressure Rating: 1000 psig minimum.

E. Temperature Rating: 500 deg F minimum.

F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.

G. Integral Transformer: For low-voltage power operation.

H. Accuracy: Plus or minus 7/10 percent for liquids and 1-1/4 percent for gases.

2.13 PITOT-TUBE FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dieterich Standard Inc.
4. Taco, Inc.

B. Description: Insertion-type, differential-pressure design for inserting probe into piping and measuring flow directly in gallons per minute.

C. Construction: Stainless-steel probe of length to span inside of pipe; with integral transmitter and direct-reading scale.

D. Pressure Rating: 150 psig minimum.

E. Temperature Rating: 250 deg F minimum.
F. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons.

G. Integral Transformer: For low-voltage power connection.

H. Accuracy: Plus or minus 1 percent for liquids and gases.

2.14 FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Dwyer Instruments, Inc.
3. Eugene Ernst Products Co.
4. McCrometer, Inc.
5. Penberthy, Inc.

B. Description: Instrument for installation in piping systems for visual verification of flow.

C. Construction: Bronze or stainless-steel body; with sight glass and plastic pelton-wheel indicator, and threaded or flanged ends.

D. Pressure Rating: 125 psig

E. Temperature Rating: 200 deg F

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.15 INSERTION-TURBINE, THERMAL-ENERGY METER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Data Industrial Corp.
2. ONICON Incorporated.
B. Description: Flow sensor, strainer, two temperature sensors, transmitter, meter, and connecting wiring.

C. Flow Sensor: Insertion-type turbine or paddle-wheel element with corrosion-resistant-metal body and transmitter.
   2. Temperature Range: 40 to 250 deg F.

D. Meter: Solid-state integrating type with integral battery pack.
   1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
   2. Accuracy: Plus or minus 1 percent.

E. Strainer: Full size of main line piping.

2.16 INLINE-TURBINE, THERMAL-ENERGY METER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Thermo Measurement Ltd.

B. Description: Flow sensor, strainer, two temperature sensors, transmitter, meter, and connecting wiring.

C. Flow Sensor: Turbine-type water meter with corrosion-resistant-metal body and transmitter.
   1. Pressure Rating: 150-psig minimum working-pressure rating.
   2. Temperature Range: 40 to 250 deg F.

D. Meter: Solid-state integrating type with integral battery pack.
1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.

2. Accuracy: Plus or minus 1 percent.


E. Strainer: Full size of main line piping.

2.17 ULTRASONIC, THERMALSENSER METER SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Controlotron Corporation.
2. Contrec
3. Panametrics

B. Description: Flow sensor, two temperature sensors, transmitter, meter, and connecting wiring.

C. Flow Sensor: Strap-on or integral ultrasonic type with transmitter.

D. Meter: Solid-state integrating type with integral battery pack.

1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.

2. Accuracy: Plus or minus 1 percent.


E. Strainer: Full size of main line piping.

2.18 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.

2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

4. Inlet and outlet of each hydronic heat exchanger.

5. Inlet and outlet of each hydronic heat-recovery unit.

6. Inlet and outlet of each thermal storage tank.

7. Outside-air, return-air, and mixed-air ducts.

B. Install direct-mounting, vapor-actuated dial thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.

2. Inlet and outlet of each hydronic boiler and chiller.

3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

4. Inlet and outlet of each hydronic heat exchanger.

5. Inlet and outlet of each hydronic heat-recovery unit.

6. Inlet and outlet of each thermal storage tank.

C. Install remote-mounting, vapor-actuated dial thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.

2. Inlet and outlet of each hydronic boiler and chiller.

3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

4. Inlet and outlet of each hydronic heat exchanger.

5. Inlet and outlet of each hydronic heat-recovery unit.

6. Inlet and outlet of each thermal storage tank.

D. Install bimetallic-actuated dial thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.

2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

4. Inlet and outlet of each hydronic heat exchanger.

5. Inlet and outlet of each hydronic heat-recovery unit.

6. Inlet and outlet of each thermal storage tank.

E. Install dry liquid-filled-case-type or vapor bimetallic-actuated dial thermometers at suction and discharge of each pump.

F. Provide the following temperature ranges for thermometers:
   1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
   2. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
   3. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
   4. Steam and Condensate: 50 to 400 deg F, with 5-degree scale divisions.
   5. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

2.19 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install dry-type pressure gauges in the following locations:
   1. Steam systems.

C. Install liquid-filled-type pressure gauges at suction and discharge of each pump and all other services, except steam.

END OF SECTION 230519
GENERAL-DUTY VALVES FOR HVAC PIPING
SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

a. Bronze gate valves.
b. Bronze globe valves.
c. Bronze swing check valves.
d. Bronze angle valves.
e. Bronze needle valves.
f. Iron gate valves.
g. Iron globe valves.
h. Iron swing check valves.
i. Iron angle valves.
j. Iron stop check valves.
k. Forged steel gate valves.
l. Forged steel globe valves.
m. Forged steel check valves.
n. Cast steel gate valves.
o. Cast steel globe valves.
p. Cast steel swing check valves.
q. Cast steel stop check valves.
r. Bronze ball valves.
s. Steel ball valves.
t. Cast iron plug valves.
u. Cast steel plug valves
v. Spring loaded lift disc check valves.
w. Calibrated balancing valves.
x. Pressure reducing valves.
y. Safety valves.
z. Automatic flow control valves.
aa. Solenoid valves.
bb. Electric valve actuators.
cc. Pneumatic valve actuators.
dd. Chain wheel actuators

B. Related Sections:
1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. Standards: If any item in this specification, as furnished by the contractor is manufactured in a location which does not certify ASME / ANSI standards, the contractor is to pay the owner for all expenses incurred by the owner for an outside testing company to confirm such compliances.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data:

1. For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

2. For each type of special duty valve indicated include flow and pressure drop curves based on manufacturer’s testing for diverting fittings, calibrated balancing valves and automatic flow control valves.

B. Maintenance Data.

1. Furnish maintenance manuals as specified in Division 1.

1. Furnish complete operation and maintenance manuals for the purchased equipment.

2. Include the following items as a minimum for the purchased equipment.
   a. Parts list.
   b. Maintenance guide.
   c. Preventive maintenance schedule.
   d. Flow / pressure drop curves.
   e. Performance data.
General-Duty Valves for HVAC Piping

2.1 GENERAL REQUIREMENTS FOR VALVES

HVAC valve applications specified in this Section are limited to NPS 24 (DN 600). Many valves specified are available in larger sizes.

A. Refer to HVAC valve schedule articles for applications of valves (Part 3 “Valve Applications Schedule”.

Caution: Revise pressure ratings and insert temperature ratings in valve articles if valves with higher ratings are required. Valves larger than NPS 12 (DN 300) typically have a lower pressure rating than smaller valves. Verify pressure requirements for large valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Hand wheel: For valves other than quarter-turn types.
3. Hand lever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
5. Chain wheel: Device for attachment to valve hand wheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
6. Pneumatic motor: For quarter turn valves as indicated on the drawings.
7. Electric motor: As indicated on the drawings.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.


F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves
2. Flanged: With flanges according to ASME B16.5 for steel valves,

Do not use threaded valves with GLYCOL systems
5. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 VALVE DESCRIPTIONS

A. BRONZE GATE VALVES, 2 INCHES AND SMALLER, MSS SP-80 TYPE 1

1. Manufacturers - Bronze gate valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co; Crane Valve Group; Crane Valves
   c. Grinnell Corporation
   d. 
   e. Walworth Company
   f. NIBCO Inc.

2. Class 150 psi steam, 300 psi cold working pressure (CWP)
   a. ASTM B 62 cast-bronze body and bonnet
   b. Union bonnet
c. Solid-bronze wedge
d. Copper-silicon alloy rising stem
e. Teflon-impregnated packing with bronze packing nut
f. Threaded (steel piping) end connection – SCHEDULE VALVE NO. 0101
g. Soldered (copper piping) end connection – SCHEDULE VALVE NO. 0102
h. Aluminum or malleable-iron hand wheel

3. Class 300 psi steam, 1000 psi cold working pressure (CWP)
   a. ASTM B 61 cast-bronze body and bonnet
   b. Union bonnet
c. Solid-bronze wedge
d. Stainless steel seat
e. Copper-silicon alloy rising stem
f. Teflon-impregnated packing with bronze packing nut
g. Threaded end connection
h. Aluminum or malleable-iron hand wheel
i. SCHEDULE VALVE NO. 0111

B. BRONZE GLOBE VALVES, 2 INCHES AND SMALLER, MSS SP-80 TYPE 3

1. Manufactures-Bronze globe valves
   a. Crane Co; Crane Valve Group; Jenkins Valves
   b. Crane Co; Crane Valve Group; Crane Valves
c. Crane Co; Crane Valve Group; Stockham Division.
d. Grinnell Corporation
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2. Class 150 psi steam, 300 psi cold working pressure (CWP)
   a. ASTM B 62 cast-bronze body and bonnet
   b. Union bonnet
   c. Stainless steel disc
   d. Stainless steel seat
   e. Copper-silicon alloy rising stem
   f. Teflon-impregnated packing with bronze packing nut
   g. Threaded end connection
   h. Aluminum or malleable-iron hand wheel
   i. SCHEDULE VALVE NO. 0201

C. Class 300 psi steam, 1000 psi cold working pressure (CWP)
   1. ASTM B 61 cast-bronze body and bonnet
      a. Union bonnet
      b. Stainless steel disc
      c. Stainless steel seat
      d. Copper-silicon alloy rising stem
      e. Teflon-impregnated packing with bronze packing nut
      f. Threaded end connection
      g. Aluminum or malleable-iron hand wheel
      h. SCHEDULE VALVE NO. 0211
D. BRONZE SWING CHECK VALVES, 2 INCHES AND SMALLER, MSS SP-80

1. Manufacturers - Bronze check valves, Horizontal and Vertical
   a. Horizontal
      1) Crane Co.; Crane Valve Group; Jenkins Valves
      2) Crane Co.; Crane Valve Group; Crane Valves
      3) Crane Co.; Crane Valve Group; Stockham Division
      4) Grinnell Corporation
      5) Walworth Company
      6) NIBCO Inc.
   b. Vertical
      1) Crane Co.; Crane Valve Group; Jenkins Valves
      2) Crane Co.; Crane Valve Group; Crane Valves
      3) Cincinnati Valve Co

2. Class 150 psi steam, 300 psi cold working pressure (CWP)
   a. ASTM B 62 cast-bronze body and cap
   b. “Y” pattern
   c. Stainless steel free floating hinge pin
   d. Threaded cap
e. Regrinding seat  
f. Bronze disc  
g. Threaded (steel piping) end connection – SCHEDULE VALVE NO. 0301

3. Class 300 psi steam, 1000 psi cold working pressure (CWP)
   a. ASTM B 61 cast-bronze body and cap  
   b. “Y” pattern  
   c. Stainless steel free floating hinge pin  
   d. Threaded cap  
   e. Regrinding seat  
   f. Bronze disc  
   g. Threaded end connection  
   h. SCHEDULE VALVE NO. 0311

E. BRONZE ANGLE VALVES, 2 INCHES AND SMALLER, MSS SP-80

1. Manufacturers- Bronze Angle Valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves  
   b. Crane Co.; Crane Valve Group; Crane Valves  
   c. Crane Co.; Crane Valve Group; Stockham Division  
   d. Grinnell Corporation  
   e. Cincinnati Valve Co.  
   f. NIBCO Inc.

2. Class 150 psi steam, 300 psi cold working pressure (CWP)
   a. ASTM B 62 cast-bronze body and bonnet
b. Union bonnet

c. PTFE disc w/ bronze holder

d. Integral bronze seat

e. Copper-silicon alloy rising stem

f. Teflon-impregnated packing with bronze packing nut

g. Threaded end connection

h. Aluminum or malleable-iron hand wheel

i. SCHEDULE VALVE NO. 0401

3. Class 300 psi steam, 1000 psi cold working pressure (CWP)

a. ASTM B 61 cast-bronze body and bonnet

b. Union bonnet

c. Stainless steel plug type disc

d. Hardened stainless steel seat ring

e. Copper-silicon alloy rising stem

f. Teflon-impregnated packing with bronze packing nut

g. Threaded end connection

h. Aluminum or malleable-iron hand wheel

i. SCHEDULE VALVE NO. 0411

F. Bronze needle valves, 1/8 inch to 3/4 inch, MSS SP-80

1. Manufacturers - Bronze Needle Valves

a. Crane Co.; Crane Valve Group; Jenkins Valves

b. Crane Co.; Crane Valve Group; Stockham Division.
2. Class 200 psi steam, 400 psi cold working pressure (CWP)
   a. ASTM B 62 cast-bronze body and bonnet
   b. Screwed bonnet
   c. Bronze ASTM B 150 rising stem & needle
   d. Integral bronze seat
   e. Graphite packing with bronze packing nut
   f. Threaded end connection
   g. Globe or angle pattern
   h. Aluminum or malleable-iron hand wheel
   i. SCHEDULE VALVE NO. 0501

G. IRON GATE VALVES

1. Manufacturers - Iron gate valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co.; Crane Valve Group; Crane Valves
   c. Crane Co.; Crane Valve Group; Stockham Division
   d. Grinnell Corporation
   e. Cincinnati Valve Co.
   f. NIBCO Inc.

2. 2 inch and smaller, MSS SP 25, MSS SP-70 type 1
a. Class 125 psi steam, 200 psi cold working pressure (CWP)
   1) ASTM A 126 class B cast-iron body and bonnet

   2) Bolted bonnet

   3) Outside screw & yoke

   4) Rising stem

   5) Solid bronze disc

   6) Bronze stem

   7) Renewable bronze seat rings

   8) Threaded end connection

   9) Non-asbestos packing and gaskets

  10) Aluminum or malleable-iron hand wheel

  11) SCHEDULE VALVE NO. 0601

b. Class 250 psi steam, 500 psi cold working pressure (CWP)
   1) ASTM A 126 class B cast-iron body and bonnet

   2) Bolted bonnet
3) Outside screw & yoke

4) Rising stem

5) Solid bronze disc

6) Steel stem

7) Renewable bronze seat rings

8) ANSI 250 flat face flanged ends

9) Non-asbestos packing and gaskets

10) Aluminum or malleable-iron hand wheel

11) SCHEDULE VALVE NO. 0602

3. 2 1/2 inch to 12 inch, MSS SP 25, MSS SP-70 type 1
   a. Class 125 psi steam, 200 psi cold working pressure (CWP)
      1) ASTM A 126 class B cast-iron body and bonnet
      2) Bolted bonnet
      3) Outside screw & yoke
      4) Rising stem
5) Solid bronze disc

6) Steel stem

7) Renewable bronze seat rings

8) ANSI 125 flat face flanged ends

9) Non-asbestos packing and gaskets

10) Aluminum or malleable-iron hand wheel

11) SCHEDULE VALVE NO. 0611

b. Class 250 psi steam, 500 psi cold working pressure (CWP)

1) ASTM A 126 class B cast-iron body and bonnet

2) Bolted bonnet

3) Outside screw & yoke

4) Rising stem

5) Solid bronze disc

6) Steel stem

7) Renewable bronze seat rings
8) ANSI 250 flat face flanged ends

9) Non-asbestos packing and gaskets

10) Aluminum or malleable-iron hand wheel

11) SCHEDULE VALVE NO. 0612

H. IRON GLOBE VALVES

1. Manufacturers - Iron globe valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co.; Crane Valve Group; Crane Valves
   c. Crane Co.; Crane Valve Group; Stockham Division
   d. Grinnell Corporation
   e. Cincinnati Valve Co.
   f. NIBCO Inc.

2. 3 inches to 10 inches, MSS SP-85
   a. Class 125 psi steam, 200 psi cold working pressure (CWP)
      1) ASTM A 126 class B cast-iron body and bonnet
      2) Bolted bonnet
      3) Outside screw & yoke
4) Rising stem

5) 6 inch and smaller: solid bronze disc

6) 8 inch and larger: cast iron disc with bronze facing

7) Bottom guided disc

8) Brass alloy stem

9) Renewable bronze seat

10) ANSI 125 flat face flanged ends

11) Non-asbestos packing and gaskets

12) Aluminum, steel, or cast iron hand wheel

13) SCHEDULE VALVE NO. 0701

b. Class 250 psi steam, 500 psi cold working pressure (CWP)

1) ASTM A 126 class B cast-iron body and bonnet

2) Bolted bonnet

3) Outside screw & yoke

4) Rising stem
5) 3 inch and smaller: solid bronze disc

6) 6 inch and larger: cast iron disc with bronze facing

7) Bottom guided disc

8) Brass alloy stem

9) Renewable bronze seat

10) ANSI 250 flat face flanged ends

11) Non-asbestos packing and gaskets

12) Aluminum, steel, or cast iron hand wheel

13) SCHEDULE VALVE NO. 0702

3. 2 inch and smaller, ASME B1.20.1
   a. Class 700 psi steam, 1000 psi cold working pressure (CWP)
      1) Malleable iron body and bonnet
      2) Union bonnet
      3) Rising stem
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4) Nickel alloy disc

5) Stainless steel stem

6) Stainless steel seat ring

7) Threaded ends

8) Non-asbestos ring packing

9) Aluminum, steel, or cast iron hand wheel

10) SCHEDULE VALVE NO. 0711

I. IRON SWING CHECK VALVES

1. Manufacturers - Iron swing check valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co.; Crane Valve Group; Crane Valves
   c. Crane Co.; Crane Valve Group; Stockham Division
   d. Grinnell Corporation
   e. Cincinnati Valve Co.
   f. NIBCO Inc.

2. 2 inch and smaller, ASME B1.20.1
   a. Class 700 psi steam, 1000 psi cold working pressure (CWP)
      1) Malleable iron body and cap
2) “Y” pattern swing check

3) Screwed cap

4) Stainless steel hinge pin

5) Iron seat

6) Threaded ends

7) SCHEDULE VALVE NO. 0801

3. 2½ inch to 12 inch, ASME B16.10
   a. Class 125 psi steam, 200 psi cold working pressure (CWP)
      1) Cast iron body and cap

      2) Replaceable bronze seat ring

      3) 6 inch and smaller: solid bronze disc

      4) 8 inch and larger: cast iron disc with bronze facing

      5) Replaceable brass hinge pin

      6) Flanged ends
7) SCHEDULE VALVE NO. 0811

b. Class 250 psi steam, 500 psi cold working pressure (CWP)

1) Cast iron body and cap, ASTM A126 class B

2) Screwed in bronze body seat ring

3) 3 inch and smaller: solid bronze disc

4) 4 inch and larger: cast iron disc with bronze facing

5) Stainless steel hinge pin

6) Flanged ends

7) SCHEDULE VALVE NO. 0812

J. IRON ANGLE VALVES

1. Manufacturers - Iron angle valves

   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co.; Crane Valve Group; Crane Valves
   c. Crane Co.; Crane Valve Group; Stockham Division
   d. NIBCO Inc.

2. 2½ inch to 6 inch, ASME B16.1, ASME B16.10

   a. Class 125 psi steam, 200 psi cold working pressure (CWP)
1) Cast iron body, bronze trim

2) Integral yoke

3) Bolted bonnet

4) Renewable /regrindable screwed in bronze seat ring

5) Solid bronze disc

6) Bottom guided disc

7) Non asbestos packing and gasket

8) ANSI 125 flat face flanged ends

9) Aluminum, steel, or cast iron hand wheel

10) SCHEDULE VALVE NO. 0901

K. IRON STOP CHECK VALVES

1. Manufacturers - Iron stop check valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co.; Crane Valve Group; Crane Valves

2. 2½ inch to 10 inch
   a. Class 250 psi steam, 500 psi cold working pressure (CWP)
1) Straightaway pattern; horizontal or vertical with upward flow installation.

2) Angle pattern; horizontal to downward or upward to horizontal flow.

3) For installation between boilers supplying the same steam header, and positioned with pressure under the disc.

4) Common features:
   a) Cast iron body, bronze trim
   b) Integral yoke
   c) Bolted bonnet
   d) Cylindrical shaped disc
   e) Flat seats
   f) Removable cast iron liner
   g) Y-pattern
   h) Raised face flanges
   i) Non asbestos packing and gasket
   j) Aluminum, steel, or cast iron hand wheel
k) SCHEDULE VALVE NO. 1001

1. FORGED STEEL GATE VALVES, 2 INCHES AND SMALLER, MSS SP-84
   a. Manufacturers - Forged steel gate valves
      i. Walworth Co.
      ii. Edward Vogt Valve Company
   b. Class 800 psi steam, 1975 psi cold working pressure (CWP), conventional port
      i. ASTM A105 forged steel body and bonnet
      ii. Bolted bonnet
      iii. Outside screw and yoke
      iv. Bolted gland
      v. Solid stainless steel, ASTM A276 wedge
      vi. Stellite faced seats
      vii. Steel / chrome alloy rising stem
      viii. Flexible graphite packing
      ix. Threaded end connection – SCHEDULE VALVE NO. 1101
      x. Socket-weld end connection – SCHEDULE VALVE NO. 1102
     xi. Malleable-iron hand wheel
   c. Class 800 psi steam, 1975 psi cold working pressure (CWP), full port
      i. ASTM A105 forged steel body and bonnet
      ii. Bolted bonnet
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- Outside screw and yoke
- Bolted gland
- Solid stainless steel, ASTM A276 wedge
- Stellite faced seats
- Steel / chrome alloy rising stem
- Flexible graphite packing
- Threaded end connection – SCHEDULE VALVE NO. 1111
- Socket-weld end connection – SCHEDULE VALVE NO. 1112
- Malleable-iron hand wheel

M. FORGED STEEL GLOBE VALVES, 2 INCHES AND SMALLER, MSS SP-84

1. Manufacturers - Forged steel globe valves
   - Walworth Co.
   - Edward Vogt Valve Company

2. Class 800 psi steam, 1975 psi cold working pressure (CWP), conventional port
   - ASTM A105 forged steel body and bonnet
   - Bolted bonnet
   - Outside screw and yoke
   - Bolted gland
   - Loose disc, steel / chrome alloy
   - Renewable satellite faced seat
   - Steel / chrome alloy rising stem
   - Flexible graphite packing
i. Threaded end connection – SCHEDULE VALVE NO. 1201
j. Socket-weld end connection – SCHEDULE VALVE NO. 1202
k. Malleable-iron hand wheel

N. FORGED STEEL CHECK VALVES, 2 INCHES AND SMALLER, MSS SP-84

1. Manufacturers - Forged steel check valves
   a. Walworth Co.
   b. Edward Vogt Valve Company

2. Class 800 psi steam, 1975 psi cold working pressure (CWP), conventional port, horizontal piston check
   a. ASTM A105 forged steel body and cover
   b. Bolted cover
   c. Fully guided disc steel / chrome alloy
   d. Renewable satellite faced seat
   e. Stainless steel / graphite gasket
   f. Threaded end connection – SCHEDULE VALVE NO. 1301
   g. Socket-weld end connection – SCHEDULE VALVE NO. 1302

O. CAST STEEL GATE VALVES, 2 INCHES TO 24 INCHES

1. Manufacturers - Cast steel gate valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co.; Crane Valve Group; Crane Valves
   c. Crane Co.; Crane Valve Group; Stockham Division
   d. Walworth Co.
2. Class 150 psi steam, 290 psi cold working pressure (CWP)
   a. ASTM A216 grade WCB cast steel body and bonnet
   b. Bolted bonnet
   c. Outside screw and yoke
   d. Rising stem
   e. Bolted gland
   f. Solid steel, 13% chromium overlay wedge
   g. Stellite faced seats
   h. Stainless steel stem
   i. Flexible graphite packing
   j. Raised face flange ends – SCHEDULE VALVE NO. 1401
   k. Butt-welding ends – SCHEDULE VALVE NO. 1402
   l. Malleable-iron or steel hand wheel

3. Class 300 psi steam, 750 psi cold working pressure (CWP)
   a. ASTM A216 grade WCB cast steel body and bonnet
   b. Bolted bonnet
   c. Outside screw and yoke
   d. Rising stem
   e. Bolted gland
   f. Solid steel, 13% chromium overlay wedge
g. Stellite faced seats  
h. Stainless steel stem  
i. Flexible graphite packing  
j. Raised face flange ends – SCHEDULE VALVE NO. 1411  
k. Butt-welding ends – SCHEDULE VALVE NO. 1412  
l. Malleable-iron or steel hand-wheel  

P. CAST STEEL GLOBE VALVES, 2 INCHES TO 12 INCHES  

1. Manufacturers - Cast steel globe valves  
a. Crane Co.; Crane Valve Group; Jenkins Valves  
b. Crane Co.; Crane Valve Group; Crane Valves  
c. Crane Co.; Crane Valve Group; Stockham Division  
d. Walworth Co.  
e. Edward Vogt Valve Company  
f.  

2. Class 150 psi steam, 290 psi cold working pressure (CWP)  
a. ASTM A216 grade WCB cast steel body and bonnet  
b. Bolted bonnet  
c. Outside screw and yoke  
d. Rising stem and hand-wheel  
e. Bolted gland  
f. Steel with 13% chromium overlay disc  
g. Stellite faced seat ring
h. Stainless steel stem
i. Flexible graphite packing
j. Raised face flange ends – SCHEDULE VALVE NO. 1501
k. Butt-welding ends – SCHEDULE VALVE NO. 1502
l. Malleable-iron or steel handwheel

3. Class 300 psi steam, 750 psi cold working pressure (CWP)
   a. ASTM A216 grade WCB cast steel body and bonnet
   b. Bolted bonnet
   c. Outside screw and yoke
d. Rising stem and hand-wheel
e. Bolted gland
f. Steel with 13% chromium overlay disc
g. Stellite faced seat ring
h. Stainless steel stem
i. Flexible graphite packing
j. Raised face flange ends – SCHEDULE VALVE NO. 1511
k. Butt-welding ends – SCHEDULE VALVE NO. 1512
l. Malleable-iron or steel hand-wheel

Q. CAST STEEL SWING CHECK VALVES, 2 INCHES TO 24 INCHES

1. Manufacturers - Cast steel swing check valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co.; Crane Valve Group; Crane Valves
c. Crane Co.; Crane Valve Group; Stockham Division

d. Walworth Co.

e. Edward Vogt Valve Company

f. 

2. Class 150 psi steam, 290 psi cold working pressure (CWP)

a. ASTM A216 grade WCB cast steel body and cover

b. Bolted cover

c. Steel with 13% chromium overlay disc

d. Stellite faced seat ring

e. Steel hinge, stainless steel hinge pin

f. Stainless steel / graphite gasket

g. Raised face flange ends – SCHEDULE VALVE NO. 1601

h. Butt-welding ends – SCHEDULE VALVE NO. 1602

3. Class 300 psi steam, 750 psi cold working pressure (CWP)

a. ASTM A216 grade WCB cast steel body and cover

b. Bolted cover

c. Steel with 13% chromium overlay disc

d. Stellite faced seat ring

e. Steel hinge, stainless steel hinge pin

f. Stainless steel / graphite gasket

g. Raised face flange ends – SCHEDULE VALVE NO. 1611

h. Butt-welding ends – SCHEDULE VALVE NO. 1612
R. CAST STEEL STOP CHECK VALVES, 3 INCHES TO 10 INCHES

1. Manufacturers - Cast steel stop check valves
   a. Crane Co.; Crane Valve Group; Crane Valves
   b. Edward Vogt Valve Co.
   c. Walworth Co.

2. Class 300 psi steam, 750 psi cold working pressure (CWP)

3. Straightaway pattern; horizontal or vertical with upward flow installation.

4. Angle pattern; horizontal to downward or upward to horizontal flow.

5. For installation between boilers supplying the same steam header, and positioned with pressure under the disc.

6. Common features:
   a. ASTM A216 grade WCB cast steel body and bonnet
   b. Integral yoke
   c. Bolted bonnet
   d. Cylindrical shaped disc, stellite faced
   e. Flat seat, 13% chrome
   f. Removable carbon steel liner
   g. Y-pattern
   h. Raised face flange ends – SCHEDULE VALVE NO. 1701
   i. Butt-welding ends – SCHEDULE VALVE NO. 1702
   j. Non-asbestos packing and gasket
   k. Ductile iron hand-wheel
S. BRONZE BALL VALVES, 3 INCHES AND SMALLER

1. Manufacturers - Bronze ball valves
   a. Conbraco Industries Inc.; Apollo Division
   b. Crane Co.; Crane Valve Group; Jenkins Valves
   c. Crane Co.; Crane Valve Group; Stockham Division
   d. Jamesbury Inc.
   e.
   f. Rockwell

2. 2 piece, class 150 psi steam, 600 psi cold working pressure (CWP), reduced port
   a. ASTM B584 cast bronze body
   b. Stainless steel ball and stem
   c. Blow out proof stem design
   d. PTFE seats
   e. PTFE stem packing
   f. Zinc plated steel lever with vinyl covered grip
   g. Solder-ends – SCHEDULE VALVE NO. 1802

3. 2 piece, class 150 psi steam, 600 psi cold working pressure (CWP), standard port
   a. ASTM B584 cast bronze body
   b. Stainless steel ball and stem
   c. Blow out proof stem design
   d. PTFE seats
   e. PTFE stem packing
f. Zinc plated steel lever with vinyl covered grip

g. Solder ends – SCHEDULE VALVE NO. 1812

4. 3 piece, class 150 psi steam, 600 psi cold working pressure (CWP), full port

   a. ASTM B584 cast bronze body
   b. Stainless steel ball and stem
   c. Chrome plated brass ball with brass stem
   d. Blow out proof stem design
   e. PTFE seats
   f. PTFE stem packing
   g. Zinc plated steel lever with vinyl covered grip
   h. Threaded ends
   i. SCHEDULE VALVE NO. 1821

T. CARBON STEEL BALL VALVES

1. Manufacturers - Steel ball valves
   a. Conbraco Industries Inc.; Apollo Division
   b. Crane Co.; Crane Valve Group; Stockham Division
   c. Rockwell
   d. Jamesbury Inc.
   e. Cooper Cameron Corp.; Cooper Cameron Valves Div.
   f. 

2. 2 piece, class 150 psi steam, 3000 psi cold working pressure (CWP), full port, 2_inches and smaller
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a. ASTM A108 carbon steel body
b. Stainless steel ball and stem
c. Blow out proof stem design
d. PTFE seats
e. PTFE stem packing
f. Zinc plated steel lever with vinyl covered grip
g. Threaded ends
h. SCHEDULE VALVE NO. 1901

3. 3 piece, class 150 psi steam, 1000 psi cold working pressure (CWP), full port, 2 inches and smaller
   a. ASTM A108 carbon steel body
   b. Stainless steel ball and stem
c. ASTM A108 chrome plated ball and stem
d. Blow out proof stem design
e. PTFE seats
f. PTFE stem packing
g. Zinc plated steel lever with vinyl covered grip

select one of two options below – do not use threaded for glycol service.
   h. Threaded ends – SCHEDULE VALVE NO. 1911
   i. Socket weld ends – SCHEDULE VALVE NO. 1912

4. ANSI flanged, class 150 psi steam, 285 psi cold working pressure (CWP), reduced port, 2½ inches to 10 inches
   a. ASTM A216 WCB cast carbon steel body
b. ASTM A216 WCB chrome plated ball

c. ASTM A108 carbon steel stem

d. Blow out proof stem design

e. PTFE seats

f. Graphite stem packing

g. Galvanized pipe lever

h. Raised face flange ends

i. SCHEDULE VALVE NO. 1921

5. ANSI flanged, class 150 psi steam, 285 psi cold working pressure (CWP), full port, 2½ inches to 6 inches

a. ASTM A216 WCB cast carbon steel body

b. ASTM A216 WCB chrome plated ball

c. ASTM A108 carbon steel stem

d. Blow out proof stem design

e. PTFE seats

f. Graphite stem packing

h. Raised face flange ends

i. SCHEDULE VALVE NO. 1931

6. ANSI flanged, class 300 psi steam, 740 psi cold working pressure (CWP), reduced port, 3 inches to 10 inches

a. ASTM A216 WCB cast carbon steel body

b. ASTM A216 WCB chrome plated ball
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c. ASTM A108 carbon steel stem  
d. Blow out proof stem design  
e. PTFE seats  
f. Graphite stem packing  
g. Galvanized pipe lever  
h. Raised face flange ends  
i. SCHEDULE VALVE NO. 1941  

7. ANSI flanged, class 300 psi steam, 740 psi cold working pressure (CWP), full port, 3\_ inches to 6 inches  
a. ASTM A216 WCB cast carbon steel body  
b. ASTM A216 WCB chrome plated ball  
c. ASTM A108 carbon steel stem  
d. Blow out proof stem design  
e. PTFE seats  
f. Graphite stem packing  
g. Galvanized pipe lever  
h. Raised face flange ends  
i. SCHEDULE VALVE NO. 1951  

U. CAST IRON PLUG VALVES  

1. Manufacturers - Cast iron plug valves  
a. Nordstrom Valve Inc.  
b. Walworth Company
c. R&M Energy systems (Tomball Tx)

d. Olson Technologies; Homestead Div.

2. 2 inch and smaller, MSS SP 25, MSS SP-78

a. 200 psi cold working pressure (CWP)

1) ASTM A 126 gray iron body

2) Regular pattern

3) Screwed gland

4) Buna-N gland and stem seals

5) Gray iron lubricated tapered plug

6) Carbon steel sealant fitting

7) 1 year supply lubricant per valve

8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

9) 1 wrench operator per 10 valves

10) Threaded end connection

11) SCHEDULE VALVE NO. 2001
b. 400 psi cold working pressure (CWP)
   1) ASTM A 126 gray iron body
   2) Short pattern
   3) Screwed gland
   4) Buna-N gland and stem seals
   5) Gray iron lubricated tapered plug
   6) Carbon steel sealant fitting
   7) 1 year supply lubricant per valve
   8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
   9) 1 wrench operator per 10 valves
  10) Threaded end connection
  11) SCHEDULE VALVE NO. 2002

3. 2 1/2 inch to 4 inch, MSS SP 25, MSS SP-78
   a. 200 psi cold working pressure (CWP)
      1) ASTM A 126 gray iron body
2) Regular pattern

3) Screwed gland

4) Buna-N gland and stem seals

5) Gray iron lubricated tapered plug

6) Carbon steel sealant fitting

7) 1 year supply lubricant per valve

8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

9) 1 wrench operator per 10 valves

10) ANSI 125 flanged ends

11) SCHEDULE VALVE NO. 2011

b. 400 psi cold working pressure (CWP)

1) ASTM A 126 gray iron body

2) Short pattern

3) Screwed gland
4) Buna-N gland and stem seals

5) Gray iron lubricated tapered plug

6) Carbon steel sealant fitting

7) 1 year supply lubricant per valve

8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

9) 1 wrench operator per 10 valves

10) ANSI 250 flanged ends

11) SCHEDULE VALVE NO. 2012

4. 5 and 6 inch, MSS SP 25, MSS SP-78
   a. 200 psi cold working pressure (CWP)
      1) ASTM A 126 gray iron body
      2) Short pattern
      3) Bolted gland
      4) Buna-N gland and stem seals
      5) Gray iron lubricated tapered plug
6) Carbon steel sealant fitting

7) 1 year supply lubricant per valve

8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

9) 1 wrench operator per 10 valves

10) ANSI 125 flanged ends

11) SCHEDULE VALVE NO. 2021

b. 400 psi cold working pressure (CWP)

1) ASTM A 126 gray iron body

2) Regular pattern

3) Bolted gland

4) Buna-N gland and stem seals

5) Gray iron lubricated tapered plug

6) Carbon steel sealant fitting

7) 1 year supply lubricant per valve
8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

9) 1 wrench operator per 10 valves

10) ANSI 250 flanged end

11) SCHEDULE VALVE NO. 2022

5. 8 inch to 12 inch, MSS SP 25, MSS SP-78

a. 200 psi cold working pressure (CWP)

1) ASTM A 126 gray iron body

2) Short pattern

3) Bolted gland

4) Buna-N gland and stem seals

5) Gray iron lubricated tapered plug

6) Carbon steel sealant fitting

7) 1 year supply lubricant per valve

8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
9)  Worm gear operator

10)  ANSI 125 flanged ends

11)  SCHEDULE VALVE NO. 2031

b.  500 psi cold working pressure (CWP)

1)  ASTM A 126 gray iron body

2)  Venturi pattern

3)  Bolted gland

4)  Buna-N gland and stem seals

5)  Gray iron lubricated tapered plug

6)  Carbon steel sealant fitting

7)  1 year supply lubricant per valve

8)  1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

9)  Worm gear operator

10)  ANSI 250 flanged ends
11) SCHEDULE VALVE NO. 2032

V. CAST STEEL PLUG VALVES

1. Manufacturers - Cast steel plug valves
   a. DeZurick
   b. Nordstrom Valve Inc.
   c. Rockwell
   d. Walworth Company

2. 2 inch and smaller, MSS SP 25, MSS SP-55
   a. Class 300, 720 psi cold working pressure (CWP)
      1) ASTM A 216 grade WCB cast carbon steel body
      2) Short pattern
      3) Buna-N weatherseal
      4) Carbon steel lubricated tapered plug
      5) Carbon steel sealant fitting
      6) 1 year supply lubricant per valve
      7) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
8) 1 wrench operator per 10 valves

9) Threaded end connection

10) SCHEDULE VALVE NO. 2101

3. 2 ½ inch to 4 inch, MSS SP 25, MSS SP-55
   a. Class 300, 720 psi cold working pressure (CWP)
      1) ASTM A 216 grade WCB cast carbon steel body
      2) Short pattern
      3) Buna-N weatherseal
      4) Carbon steel lubricated tapered plug
      5) Carbon steel sealant fitting
      6) 1 year supply lubricant per valve
      7) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
      8) 1 wrench operator per 10 valves
      9) ANSI 300 raised face flanged ends
     10) SCHEDULE VALVE NO. 2121
4. 6 inch, MSS SP 25, MSS SP-55
   a. Class 300, 720 psi cold working pressure (CWP)
      1) ASTM A 216 grade WCB cast carbon steel body
      2) Venturi pattern
      3) Buna-N gland and stem seals
      4) Gray iron lubricated tapered plug
      5) Carbon steel sealant fitting
      6) 1 year supply lubricant per valve
      7) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
      8) 1 wrench operator per 10 valves
      9) ANSI 300 raised face flanged ends
     10) SCHEDULE VALVE NO. 2131

5. 8 inch to 24 inch, MSS SP 25, MSS SP-55
   a. Class 300, 720 psi cold working pressure (CWP)
      1) ASTM A 216 grade WCB cast carbon steel body
2) Venturi pattern

3) Buna-N gland and stem seals

4) Gray iron lubricated tapered plug

5) Carbon steel sealant fitting

6) 1 year supply lubricant per valve

7) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

8) Worm gear operator

9) ANSI 300 raised face flanged ends

10) SCHEDULE VALVE NO. 2141

W. SPRING LOADED LIFT DISC CHECK VALVES

1. Manufacturers - Spring loaded lift disc check valves.
   a. APCO
      a. Mueller Steam Specialty Co.
      b.
      c. Titan Flow Control, Inc.
d. William-Hager

2. 2 inch and smaller
   a. 200 psi cold working pressure (CWP) up to 150°F
      1) Cast iron body and cap
      2) Screwed cap
      3) EPDM seal
      4) Stainless steel stem
      5) Stainless steel spring
      6) Brass disc
      7) Threaded ends
      8) SCHEDULE VALVE NO. 2401
   b. 400 psi cold working pressure (CWP) up to 150°F
      1) Bronze body and cap
      2) Screwed cap
      3) EPDM seal
      4) Stainless steel stem
      5) Stainless steel spring
      6) Brass disc
      7) Threaded ends
      8) SCHEDULE VALVE NO. 2402
3. 2½ inch to 12 inch
   a. 200 psi cold working pressure (CWP) up to 150°F
      1) ASTM A126 grade B cast iron, globe style, body
      2) ASTM B62 bronze disc and seat
      3) Stainless steel spring
      4) Silicon bronze guide pins and bushings
      5) ANSI class 125 flanged end connections
      6) SCHEDULE VALVE NO. 2411
   b. 285 psi cold working pressure (CWP) up to 100°F
      1) ASTM A216 grade WCB carbon steel, globe style, body
      2) ASTM A351 stainless steel disc and seat
      3) Stainless steel spring
      4) Stainless steel guide bushings
      5) ANSI class 150 flanged end connections
      6) SCHEDULE VALVE NO. 2412
   c. 500 psi cold working pressure (CWP) up to 150°F
      1) ASTM A126 grade B cast iron, globe style, body
      2) ASTM B62 bronze disc and seat
      3) Stainless steel spring
      4) Silicon bronze guide pins and bushings
      5) ANSI class 250 flanged end connections
6) SCHEDULE VALVE NO. 2413

d. 740 psi cold working pressure (CWP) up to 100°F
   1) ASTM A216 grade WCB carbon steel, globe style, body
   2) ASTM A351 stainless steel disc and seat
   3) Stainless steel spring
   4) Stainless steel guide bushings
   5) ANSI class 300 flanged end connections

4. 12 inch to 24 inch
   a. 150 psi cold working pressure (CWP) up to 150°F
      1) ASTM A126 grade B cast iron, globe style, body
      2) ASTM B62 bronze disc and seat
      3) Stainless steel spring
      4) Silicon bronze guide pins and bushings
      5) ANSI class 125 flanged end connections
      6) SCHEDULE VALVE NO. 2421

   b. 285 psi cold working pressure (CWP) up to 100°F
      1) ASTM A216 grade WCB carbon steel, globe style, body
      2) ASTM A351 stainless steel disc and seat
      3) Stainless steel spring
      4) Stainless steel guide bushings
5) ANSI class 150 flanged end connections

6) SCHEDULE VALVE NO. 2422

c. 300 psi cold working pressure (CWP) up to 150°F
1) ASTM A126 grade B cast iron, globe style, body
2) ASTM B62 bronze disc and seat
3) Stainless steel spring
4) Silicon bronze guide pins and bushings
5) ANSI class 250 flanged end connections
6) SCHEDULE VALVE NO. 2423

d. 740 psi cold working pressure (CWP) up to 100°F
1) ASTM A216 grade WCB carbon steel, globe style, body
2) ASTM A351 stainless steel disc and seat
3) Stainless steel spring
4) Stainless steel guide bushings
5) ANSI class 300 flanged end connections
6) SCHEDULE VALVE NO. 2424

X. CALIBRATED BALANCING VALVES

1. Manufacturers - Calibrated balancing valves
   a. ITT Bell & Gossett
   b. Macon, Tunstall Corp.
   c. Nexus

2. 2 inch and smaller
   a. 200 psi cold working pressure (CWP) up to 250°F
      1) Bronze body, straight through ball valve design
General-Duty Valves for HVAC Piping

2) Brass ball
3) Carbon filled TFE seat rings
4) Read out ports with internal EPT insert and check valve
5) ¼ inch NPT tapped drain port
6) Memory stop feature
7) Calibrated nameplate
8) Sweat ends
9) SCHEDULE VALVE NO. 2501

b. 300 psi cold working pressure (CWP) up to 250°F
   1) Bronze body, straight through ball valve design
   2) Brass ball
   3) Carbon filled TFE seat rings
   4) Read out ports with internal EPT insert and check valve
   5) ¼ inch NPT tapped drain port
   6) Memory stop feature
   7) Calibrated nameplate
   8) Threaded ends
   9) SCHEDULE VALVE NO. 2502

3. 2½ inch to 3 inch
   a. 175 psi cold working pressure (CWP) up to 250°F
1) Cast iron body, straight through ball valve design
2) Brass ball
3) Carbon filled TFE seat rings
4) Read out ports with internal EPT insert and check valve
5) Memory stop feature
6) Calibrated nameplate
7) ANSI class 125 flanged end connections
8) SCHEDULE VALVE NO. 2511

4. 3 inch to 12 inch
   a. 175 psi cold working pressure (CWP) up to 250°F
      1) Cast iron body, “Y” pattern globe valve design
      2) Bronze seat
      3) Replaceable bronze disc
      4) EPDM seal insert
      5) Stainless steel stem
      6) Read out ports with internal EPT insert and check valve
      7) Memory stop feature
      8) Calibrated nameplate
      9) ANSI class 125 flanged end connections
     10) SCHEDULE VALVE NO. 2521

Y. PRESSURE REDUCING VALVES

1. Steam pressure reducing valves
   a. Leslie Controls, Inc
   b. Spence Engineering Company, Inc.
2. Class 300 steam pressure reducing valve, 1 inch to 6 inches
   a. ASTM A 216 grade WCB cast carbon steel body
   b. Normally closed, air to open
   c. Integral stainless steel seat ring with cobalt nickel alloy hard facing
   d. Replaceable diaphragm and stem seal
   e. Suitable for dead end service with maximum leakage to ANSI B16.104 class IV
   f. Actuator shall be bolted to valve bonnet and capable of closing valve against 250 psig line pressure drop
   g. Teflon graphite packing
   h. Cage retained internal valve parts
   i. Valve and control device shall be supplied by the same manufacturer
   j. ANSI class 300 flanged end connections
   k. SCHEDULE VALVE NO. 2601

Z. SAFETY VALVES

1. Manufacturers - Safety valves
   a. Conbraco Industries Inc.
   b. Kunkle

2. Class 300 steam safety shut off valve, 1 inch to 6 inches
   a. ASTM A 216 grade WCB cast carbon steel body
   b. Normally closed, air to open
   c. Integral stainless steel seat ring with cobalt nickel alloy hard facing
   d. Replaceable diaphragm and stem seal
General-Duty Valves for HVAC Piping

- Suitable for dead end service with maximum leakage to ANSI B16.104 class IV
- Actuator shall be bolted to valve bonnet and capable of closing valve against 250 psig line pressure drop
- Teflon graphite packing
- Cage retained internal valve parts
- Valve and control device shall be supplied by the same manufacturer
- ANSI class 300 flanged end connections

3. Class 300 steam safety relief valve, 1¼ inch to 6 inches (inlet)
   - 15 to 410 psig at 800°F
   - ASTM A 216 grade WCB cast carbon steel body
   - Stainless steel nozzle
   - Stainless steel disc
   - Exposed, cadmium plated, carbon steel spring
   - Bolted steel yoke
   - Stainless steel stem
   - Ductile iron lift cam and lever
   - ANSI class 300 flanged inlet connection
   - ANSI class 150 flanged outlet connection

AA. AUTOMATIC FLOW CONTROL VALVES

1. Manufacturers - Automatic flow control valves
a. Griswold Controls

2. ½ inch to 2 inch
   a. 600 psi cold working pressure (CWP)
      1) ASTM B283 forged brass body
      2) 304 stainless steel cartridge
      3) 17-7 PH stainless steel spring
      4) ¼ NPT taps with pressure/temperature test valves
      5) FNPT threaded ends
      6) SCHEDULE VALVE NO. 2801

3. 2½ inch to 3 inch
   a. 362 psi cold working pressure (CWP) up to 275°F
      1) ASTM A536-80 ductile iron body
      2) 304 stainless steel cartridge
      3) 17-7 PH stainless steel spring
      4) ¼ NPT taps with pressure/temperature test valves
      5) Pressure/temperature extensions
      6) ANSI class 150 wafer type construction
      7) SCHEDULE VALVE NO. 2811

4. 3 inch to 14 inch
   a. 200 psi cold working pressure (CWP) up to 250°F
      1) ASTM A126-61T gray iron body
2) 304 stainless steel cartridge
3) 17-7 PH stainless steel spring
4) ¼ NPT taps with pressure/temperature test valves
5) Pressure/temperature extensions
6) Plated steel studs and nuts
7) ANSI class 150 wafer type construction
8) SCHEDULE VALVE NO. 2821

5. 16 inch to 24 inch
   a. 200 psi cold working pressure (CWP) up to 250°F
      1) ASTM A126-61T gray iron body
      2) 304 stainless steel cartridge
      3) 17-7 PH stainless steel spring
      4) ¼ NPT taps with pressure/temperature test valves
      5) Pressure/temperature extensions
      6) Plated steel studs and nuts
      7) Rigging/lifting eyebolt
      8) ANSI class 150 wafer type construction
      9) SCHEDULE VALVE NO. 2831

BB. SOLENOID VALVES

1. Solenoid valves
a. ASCO

2. 2 inch and smaller, 125 psi cold working pressure (CWP)
   a. Brass body
   b. NBR disc
   c. PTFE seals
   d. Stainless steel trim
   e. Disc closing speed snubber

select one of the two options below. coordinate with electrical & controls.
   f. 24 VDC – schedule valve no. 2901
   g. 120 VAC – schedule valve no. 2902
   h. Threaded end connections

2.3 ELECTRIC MOTOR ACTUATORS

1. Manufacturers - Electric valve actuators
   a. Limitorque Corporation
   b. Rotork Controls, Inc.
   c. Belimo Air Controls, Inc.
   d. EIM Company, Inc.

B. Motor valve operators.

C. Provide as follows:

   1. Mount operators on side or top of valve at factory or at site under manufacturer's supervision. Provide gear operated single or double reduction. For 90 deg (1/4 turn) application, adjustable mechanical stops shall prevent travel of more than 90 deg
2. Grease or oil lubricated.

Select one (1) of the three (3) options below. Coordinate with electrical. Note many fractional horsepower actuators are available in 460V 3 phase only.

3. 120 Volt, 1 phase, 60 hertz

4. 208 Volt, 3 phase, 60 hertz

5. 460 Volt, 3 phase, 60 hertz

Select one (1) of two (2) options below. Coordinate with electrical department and controls engineer.

6. Control circuit: 24 volt, transformer as required.

7. Control circuit: 120 volt, transformer as required.

8. Assembly:

   a. Motor shall be high speed, high torque, totally enclosed non-ventilated, Class B or F insulation and operational at up to 10 percent above or below nominal voltage. Motor shall be pre-lubricated, anti-friction bearing type with thermal overload protection.

   b. Limit switches shall be integral to the unit. Gearing shall be bronze or stainless steel. Steel switches shall be fully adjustable and shall trip anywhere between full open and full close, as required. Switches shall be heavy duty, open contact type with rotary wiping action. Provide minimum spare contacts 2 normally open, 2 normally closed.

   c. Torque switch shall have torque protection either direction, fully adjustable and shall shut off actuator motor when a predetermined amount of torque is reached.

   d. Stem nut shall be high tensile bronze or material compatible to the valve stem and shall be constructed for easy removal without disassembling gear case.

   e. Hand-wheel for manual operation: Hand-wheel shall declutch automatically when motor is energized. Rimpull shall not exceed a maximum of 80 lb. Hand-wheel shall be similar to Limitorque SMB and SMC.

9. For open/closed operation: All valves shall have integral control package including control transformer with fused secondary, motor reversing contactor (mechanically interlocked), limit switch compartment heater and terminal strip.
a. Indicating lights shall be:
   1) Red light glows when valve closed.
   2) Green light glows when valve open.
   3) Intermediate position indication.

b. Pushbutton station: Provide selector switch if required and momentary or maintained contacts as required.

10. For modulating service shall be controlled by analog signal 4-20 ma DC with momentary pushbuttons.
   a. Controls shall be mounted inside the actuator.
   b. Provide three phase power supply:
      1) Solid state reversing controller.
      2) Comparator circuit module.
      3) Transformer.
      4) 2 position selector switch (auto/manual).
      5) Limit switch compartment heater.
      6) Mechanical dial position indicator with 1,000 ohm potentiometer.
      7) Class F insulation motor.
      8) Mounted and wired.
      9) Similar to Limitorque Modutronic 30.
   c. Provide single phase power supply:
      1) Comparator circuit module.
2) Mechanical dial position indicator with 1,000 ohm potentiometer feedback.

3) 2 position (auto/manual) selector switch.

4) Limit switch compartment heater.

5) Motor: 2100 rpm D.C. in lieu of A.C.; class F insulation; 20 percent run valve duty.

6) Mounted and wired, similar to Limitorque Modutronic 10A and 10B.

11. Closing time:

   a. Gate shall be 12 inches per minute, minimum 1 minute.
   b. Globe shall be 4 inches per minute, minimum 1 minute.
   c. Butterfly shall be 1/4 turn per minute.

12. Provide remote open-close buttons and open-close indicating lights for installation on control board in Division 15 Section “Automatic Controls System”.

13. Final field adjustment of valve operation shall be made by manufacturer's representative.

2.4 PNEUMATIC VALVE ACTUATORS

1. Manufacturers - Pneumatic valve actuators

   a. Bettis Actuators and Controls
   b. Bray Valve & Controls
   c. Neles Jamesbury

B. For conditions of service requiring torque output to 16,500 lb.-in (1,865 Nm)

1. Design Features

   a. All actuator torques must be published and must be guaranteed by the original manufacturer as minimum values. The actuator shall be sized to produce a torque equal to or greater than the maximum valve torque including safety factor...
as stated by the valve manufacturer for the service operating conditions and ambient temperatures intended.

b. Quarter turn.

c. Opposed piston, rack and pinion type.

d. Capable of 100º rotation.

e. With open and closed position stops allowing a minimum of 20º total travel adjustment.

f. Rated for continuous operation using dry instrument air at pressure from 40 – 120 PSIG.

g. Suitable for mounting in any positions.

h. Trim suitable for installed location and ambient conditions form -40ºF (-40ºC) to +350ºF (+177ºC).

i. Double acting or spring return.

j. In accordance with 150 9001 quality standard to meet 150/DIN dimensional standards.

k. With replaceable self lubricating thermoplastic upper and lower pinion, piston head on heel bearings.

l. Pressure containing seals outboard of all bearings.

m. Self threading fasteners on metal to metal pressure seals not acceptable.

n. With side located bi-directional pinion travel stops to provide ±5º of valve travel adjustment between 80º and 100º of valve travel. Travel stops are to absorb the maximum rated torque of the actuator and the maximum impact loads associated with the maximum stroke speed.

o. Full tooth engagement, at the pitch line, shall be maintained throughout the full range of travel.

p. Attachment of shaft driven accessories shall not require removal of the visual position indicator.
q. Gear teeth shall be designed to AGMA specifications, minimizing back lash and suitable for shuttling applications.

2. Construction
   a. Body: Precision extruded aluminum alloy hard anodized with fluoropolymer coat deposition process inside and out after finished machining.
   b. Fasteners: 316 stainless steel.
   c. Output shaft: One piece steel, blow out proof, secured by a redundant stainless steel retaining ring for safety. Shaft bearing material suitable for either standard or high temperature as required.
   d. End cap: Cast aluminum alloy with UV and chip resistant polyester coating.
   e. With internal porting to permit use of either direct mount or remote controls.
   f. With mechanical, indexable visual position indicator and accessory drive.
   g. Pinion gear: Alloy steel, corrosion protected.
   h. Pistons: Cast aluminum alloy, dichromatic dipped.
   i. Seals:
      1) Standard service – Nitride -40°F (-40°C) to +180°F (-82°C)

3. Accessories:
   a. Detachable manual override gear operation.
      1) Direct couple to actuator.
      2) Mounting without addition or removal of the existing valve hardware.
      3) Capable of full rated torque of the actuator.
   b. Partial test stroke device.
c. End of stroke locking device.

4. Bettis RPC series

C. For conditions if service requiring torque output to 104,000 LB.IN (11,752 Nm).

1. Design Features

a. All actuator torque must be published and must be guaranteed by the manufacturer as minimum values. The actuators shall be sized to produce a torque equal to or greater than the maximum valve torque including safety factor as stated by the valve manufacturer for the service operating condition and ambient temperatures intended.

b. Quarter turn.

c. Double acting or spring return.

d. Balanced scratch yoke design producing a torque output at both the 0° and 90° positions of at least 1 ½ times the minimum torque output.

e. Sealed to prevent entry of water, atmospheric corrosive gases and airborne abrasive dust or water.

f. Power cylinder mounted rigidly to the actuator housing using metal to metal interfaces and weather tight seals. The power cylinder shall be retained by protected internal tie bars, machine thread on the outside diameter of the cylinder, or rigidly attached by external bolting to the main housing. The use of external tie bars or brace rods on the pneumatic power cylinder is not permitted.

g. Yoke trunion and piston rod bearings shall be permanently lubricated high performance.

h. Bearings

1) Materials to accommodate installed conditions of service.

2) With self lubricating, corrosion resistant and wear resistant surface for maximum service life.
i. Instrument tubing and fittings shall be 316 stainless steel.

j. Bi-directional actuator travel stops positively cooled and friction locked to prevent changes due to vibration and impact loads. Integral to the actuator allowing 80° to 100° total travel adjustment. Capable of stopping the actuator maximum torque output.

k. Rated for continuous operation using instrument air at pressure up to 250 PSIG.

l. The housing and non-pressurized cylinder elements shall be environmentally protected by a normally closed vent system facilitating a positive purge during operation.

2. Accessories
   a. Detachable manual override gear operation.
      1) Capable of full rated torque of the actuator.
   
   b. Position indicator.
   
   c. Partial test stroke device.


2.5 CHAINWHEEL ACTUATORS

A. Manufacturers - Chainwheel actuators
   1. Babbitt Steam Specialties Co.
   2. Roto Hammer Industries Inc.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Sprocket Rim with Chain Guides Ductile iron of type and size required for valve.
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
3. Chain:
   a. Hot-dip, galvanized steel

2.6 SUBMITTALS

1. For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

2. For each type of special duty valve indicated include flow and pressure drop curves based on manufacturer’s testing for diverting fittings, calibrated balancing valves and automatic flow control valves.

3. Provide manufacturer’s certification as a proof of newly manufactured valves. Refurbished valves are not acceptable.

B. Maintenance Data.

1. Furnish maintenance manuals as specified in Division 1.

2. Furnish complete operation and maintenance manuals for the purchased equipment.

3. Include the following items as a minimum for the purchased equipment.
   a. Parts list.
   b. Maintenance guide.
   c. Preventive maintenance schedule.
   d. Flow / pressure drop curves.
   e. Performance data.
   f. Lubrication schedule.
2.7 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. Standards: If any item in this specification, as furnished by the contractor is manufactured in a location which does not certify ASME / ANSI standards, the contractor is to pay the owner for all expenses incurred by the owner for an outside testing company to confirm such compliances.

2.8 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

The Section Text is arranged to provide bronze or brass valves in NPS 2 (DN 50) and smaller and iron valves in NPS 2-1/2 to NPS 24 (DN 65 to DN 600).
Caution: Verify that valve classes and pressure and temperature ratings are adequate for system fluid. Repeat each category listing if necessary and insert required pressure range for each listing. Indicate location of each different pressure system on Drawings.

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
   1. Shutoff Service except Steam: Ball, butterfly or gate valves.
   2. Shutoff service, Steam: gate valves.
   3. Throttling Service except Steam: Ball, butterfly, plug valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
D. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

E. Install spring loaded check valves at each pump discharge and elsewhere as required to control flow direction.

F. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to discharge. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

G. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

H. Threaded connections are not to be used for glycol systems.

2.9 VALVE SCHEDULE

abbreviations
CW- Condenser water
CHW – Chilled water
HW – hot water
HTHW – High temperature hot water
lps – low pressure steam
mps – medium pressure steam
hps – high pressure steam

The pressures are listed next to the service (i.e. <125 psig is less than 125 psig.
DELETE all items in the tables not used

A. The valve numbers listed in the tables below correspond to the valve numbers listed in the products section for each valve type.

B. Table abbreviations
1. CW- Condenser water
2. CHW – Chilled water
3. HW – hot water
4. HTHW – High temperature hot water
5. LPS – low pressure steam
6. MPS – medium pressure steam, classified as high pressure steam, however the requirements may vary
7. HPS – high pressure steam
8. The pressures are listed next to the service (i.e. <125 psig is less than 125 psig, 126-250 is between 126 and 250 psig, >251 is greater than 251 psig).

C. Gate valves

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J. Plug valves

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### K. Spring loaded lift disc check valves

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### L. Calibrated balancing valves

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General-Duty Valves for HVAC Piping
230523 - 73
### M. Pressure reducing valves

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<td>HPS 126-300</td>
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### N. Safety valves

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### O. Automatic flow control valves

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## General-Duty Valves for HVAC Piping

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### P. Solenoid valves

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END OF SECTION 230523

P:\Y120000\Y120037\000 NY Presbyterian Hospital, Design Equipment\Specifications\Mech\230523_FL_general duty valves for hvac piping\AKF.DOC
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
1.1 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Fiberglass pipe hangers.
   4. Metal framing systems.
   5. Fiberglass strut systems.
   6. Thermal-hanger shield inserts.
   7. Fastener systems.
   8. Pipe stands.
   9. Equipment supports.

B. Related Sections include the following:
   1. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   2. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   3. Division 23 Section(s) "Metal Ducts Metal Ducts" and "Nonmetal Ducts Nonmetal Ducts" for duct hangers and supports.

1.2 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code-Steel."
4. AWS D1.4, "Structural Welding Code-Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Fiberglass strut systems. Include Product Data for components.
4. Pipe stands. Include Product Data for components.
5. Equipment supports
C. Submit to the structural engineer:

1. Details of all proposed methods of attachment to the building structure for all hangers and supports.

2. All forces and weights that will be imposed on the building structure by the hangers and supports.

D. Welding certificates.

E. Factory quality control and test reports.

F. Warranty

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. AAA Technology & Specialties Co., Inc.

2. B-Line Systems, Inc.; a division of Cooper Industries.

3. Carpenter & Paterson, Inc.

4. Fee & Mason

5. Grinnell Corp.

6. GS Metals Corp.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer’s standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
1. Carpenter & Paterson, Inc.

2. ERICO/Michigan Hanger Co.

3. PHS Industries, Inc.

4. Pipe Shields, Inc.

5. Rilco Manufacturing Company, Inc.

6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

   a. Hilti, Inc.

   b. ITW Ramset/Red Head.

   c. Masterset Fastening Systems, Inc.

   d. MKT Fastening, LLC.

   e. Powers Fasteners.
B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.6 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.
   c.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:
   a. MIRO Industries.
   b.
D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

c. Portable Pipe Hangers.


3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:

a. Portable Pipe Hangers.

b.

2. Bases: One or more plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS
A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

2.9 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.

   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

   a. Light (MSS Type 31): 750 lb.

   b. Medium (MSS Type 32): 1500 lb.

   c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529
SECTION 230533 - HEAT TRACING FOR HVAC PIPING

1.1 SUMMARY

A. This Section includes heat tracing with the following electric heating cables:
   1. Plastic-insulated, series resistance.
   2. Self-regulating, parallel resistance.

B. Related Sections include the following:
   1. Division 21 Section "Heat Tracing for Fire-Suppression Piping."
   2. Division 22 Section "Heat Tracing for Plumbing Piping."

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
   1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.

C. Field quality-control and test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
   2. Raychem; a division of Tyco Thermal Controls.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Heating Element: Pair of parallel No. 16 AWG, nickel-coated stranded copper bus wires embedded in cross-linked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

B. Electrical Insulating Jacket: Flame-retardant polyolefin.

C. Cable Cover: Tinned-copper Stainless-steel braid, and polyolefin outer jacket with UV inhibitor.

D. Maximum Operating Temperature (Power On): 150 deg F. Verify temperature of circulated media in freeze-protected piping in first paragraph below.

E. Maximum Exposure Temperature (Power Off): 185 deg F. Maximum Operating Temperature: 300 deg F. If more than one electric heating cable configuration is required on Project, delete paragraph and subparagraphs below and schedule electric heating cable configurations on Drawings.

F. Capacities and Characteristics:
   1. Maximum Heat Output: 10 W/ft
   2. Piping Diameter: <Insert NPS.>
   3. Number of Parallel Cables: <Insert number.>
5. Volts: 120 208 240 277 480 <Insert value> V.
6. Phase: <Insert value.>
10. Maximum Overcurrent Protection: <Insert value.>

2.3 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.4 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.


2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

END OF SECTION 230533
MECHANICAL VIBRATION ISOLATION AND SEISMIC RESTRAINT SYSTEMS
SECTION 230548 — MECHANICAL VIBRATION ISOLATION AND SEISMIC RESTRAINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. It is the objective of this Specification to provide the necessary design requirements for the control of excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork or conduit. It is also the objective of this specification to provide the design criteria for seismic restraints for all isolated and non-isolated equipment.

B. Work in this section includes the providing of labor, materials, equipment and services necessary for a complete and safe installation in of vibration isolation systems and seismic restraints for every mechanical system including piping and ductwork within and on the roof of the building, complete, as shown and specified per the contract documents and all applicable codes and authorities having jurisdiction.

C. The work of this section includes, but is not limited to the following:

1. Vibration isolation elements for piping and equipment.
2. Equipment isolation bases.
3. Piping flexible connections.
4. Seismic restraints for isolated and non-isolated piping, tanks, stacks, ductwork, VAV boxes, and equipment.

D. Related Sections:

1. All Division 23000 Sections as issued for this project under "Mechanical/HVAC".
E. Seismic restraints:

1. All equipment, piping and ductwork shall be adequately restrained to resist seismic forces. This specification is in addition to the specified vibration isolation for this project. Restraint devices shall be designed and selected to meet seismic requirements as defined in the latest issue of the state and local codes and other authorities having jurisdiction.

2. Anchor bolt calculations, signed and stamped by a registered Professional Engineer, shall be submitted showing adequacy of the bolt sizing and type. Calculations shall include anchor embedment, minimum edge distance and minimum center distance. The design lateral forces shall be distributed in proportion to the mass distribution of the equipment. Calculations shall be furnished for anchors on restraint devices, cables, isolators and on rigid mounted equipment. The seismic designer must perform final jobsite inspection to verify anchor installation.

3. Contractor shall supply all supplemental steel required for all equipment, ductwork and piping including roof mounted equipment.

4. All isolators and equipment shall meet OSHPD requirements and contain approval from OSHPD.

F. This specification shall be supplemented by all local codes and ordinance which shall take precedence in the event of the existence of any conflict between same and this specification. Where methods or materials specified are equivalent to the code requirements specified, comply with the specified requirements.

1.3 SUBMITTALS

A. In addition to the requirements of the section on Mechanical General Provisions, the submittal material shall include thirteen (13) copies of descriptive data for all products and materials including, but not limited to, the following:

1. Descriptive Data:
   
a. Catalog cuts and data sheets on specific vibration isolators and seismic restraints to be utilized showing compliance with the specifications.
b. An itemized list showing the items of equipment or piping to be isolated, the isolator type and model number selected, isolator loading and deflection, and reference to specific drawings showing seismic restraints, base and construction where applicable.

c. An itemized list of non-isolated equipment, piping, and ductwork to be seismically restrained.

d. Seismic restraint calculations.

e. Riser supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

f. Structural or civil engineer’s stamp verifying design and calculations for seismic restraining systems used.

2. Shop Drawings:

a. Drawings showing equipment base constructions for each machine, including dimensions, structural member sizes and support point locations.

b. Drawings showing methods of suspension, support guides for piping and ductwork.

c. Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.

d. Concrete and steel details for bases, including anchor bolt locations.

e. Number and location of seismic restraints and anchors for each piece of equipment and of ductwork and piping.
f. Specific details of restraints, including anchor bolts for mounting and maximum loading at each location for each piece of equipment and lengths of ductwork and piping.

1.4 CODE AND REFERENCE STANDARD REQUIREMENTS

A. All equipment supplied under this specification shall conform in all respects to the rules and regulations of:

1. SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems." 1982

2. State of California Title 24 with all applicable amendments

3. 2003 ASHRAE GUIDE, Chapter 47, and Chapter 54

4. All applicable state and local codes and authorities having jurisdiction.

5. American Society for Testing and Materials:

6. American Welding Society:

1.5 QUALITY ASSURANCE

A. All vibration isolation and seismic restraint devices shall be the product of a single manufacturer. Products of other manufacturer's are acceptable provided that their systems comply with the design intent for system performance, static deflection and structural design of the base manufacturer.
B. Vibration isolation firms having a minimum ten years experience designing and supervising the installation of vibration isolation and seismic restraint systems shall be qualified to provide the materials and installation required by this section. Project listings shall be provided including geographical location and a reference contact.

C. The installation of all vibration isolation units, and associated seismic restraints, hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer’s representative. The isolation manufacturer is to send a letter stating that they have inspected all of the vibration isolation units installed and they are installed properly and operating.

D. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed civil or structural engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver each item as a factory-assembled unit with protective crating and covering.

B. Store in a dry location.

C. Provide disassembly and re-assembly as required to accommodate rigging and shipping.

D. Comply with the manufacturer’s written rigging and installation instructions for unloading, transporting and setting in final location.

E. All equipment with shaft bearings (pump, fans, etc..) must have the shaft rotated every 2 weeks and the equipment must be stared inside.

1.7 SUBSTITUTIONS

A. Any proposed substitution must be submitted at the time the bid is submitted. No substitute material or manufacturer of equipment shall be permitted without a formal written submittal to the engineer which includes all dimensional, performance and material specifications and is approved in writing by the engineer. Any changes in layout or design brought about by the use of a substitution shall be submitted to the engineer fully designed for review in conjunction with the submittal of the alternate. Any substitutions must be submitted with an explanation.
why a substitution is being proposed. If the substitute is being proposed for financial reasons the associated credit must be simultaneously submitted.

B. Final acceptance or rejection of any substitution is subject to the Owner’s review.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Coordinate with the architect and structural engineer for concrete, reinforcement, and formwork requirements.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following are approved manufacturers, provided their systems strictly comply with the design intent for performance, deflection and structural capacity of this specification.

1. Mason Industries, Inc., Hauppauge, NY
2. Vibration Mountings & Controls, Inc., Bloomingdale, NJ
3. Vibration Eliminator Co., Inc., NY
4. Amber Booth, Houston, TX
5. Kinetics Noise Control, Inc

2.2 DESCRIPTION

A. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified,
thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

B. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.

C. Where spring isolation systems are described in the following specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the springs remain parallel. The minimum deflection from loaded operating height to spring solid height shall be 50% of the rated static deflection of the spring.

D. Where neoprene-in-shear isolation systems are described in the following specifications, the mounting assemblies shall utilize bare neoprene elements with unit type design molded in oil resistant neoprene. The neoprene shall be compounded to meet the following:

1. Shore hardness of 35 to 65 ±5, after minimum aging of 20 days or corresponding oven-aging.

2. Minimum tensile strength of 2000 PSI.

3. Minimum elongation of 300 %.

4. Maximum compression at 25 % of original deflection.

E. The isolator ratio of lateral to vertical stiffness shall not be less than 0.9 nor more than 1.5.

F. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10%.

G. All mounting systems, including seismic restraints, exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) to be hot dip galvanized. Springs shall be powder coated and neoprene coated. Nuts and bolts shall be cadmium plated.
H. All roof-mounted isolators shall be bolted or welded to building steel and anchored to the concrete deck to resist 110 mph wind loads.

2.3 MANUFACTURER RESPONSIBILITIES

A. Manufacturer of vibration isolation and seismic restraint equipment shall have the following responsibilities:
   1. Determine vibration isolation and seismic restraint sizes and locations.
   2. Provide piping and equipment isolation systems and seismic restraints as scheduled or specified.
   4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.

2.4 VIBRATION ISOLATORS

A. Type A: Bare spring isolators shall incorporate the following:
   1. Minimum 1/4" (6 mm) thick neoprene acoustical base pad on underside, unless designated otherwise.
   2. Non-resonant with equipment forcing frequencies or support structure natural frequencies.
   3. Requires seismic restraint type II
   4. Spring isolators to be Mason Type SLF, or as approved.

B. Type B: Spring isolators shall be same as Type A, except:
   1. Provide built-in vertical limit stops with minimum 1/4" (6 mm) clearance under normal operation.
   2. Tapped holes in top plate for bolting to equipment.
3. Capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.

4. Shall incorporate snubbing restraint in all directions. Cast or aluminum housings are unacceptable. System to be field bolted or welded to deck with ability to resist forces of 1.5 g acceleration.

5. Mason Type SLR, or as approved.

C. Type C: Spring hanger rod isolators shall incorporate the following:

1. Spring element seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.

2. Steel retainer box encasing the spring and neoprene cup.

3. Provide sufficient clearance between retainer box and spring hanger rod to permit minimum 15 degree allowable rod misalignment in any direction, total 30 degrees.

4. Requires seismic restraint type III

5. Mason Type TPC-30N, or as approved.

6. Where operating weight differs from installed weight, provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.

D. Type D: Elastomer Mounting Types/Elastomer Isolators, shall incorporate the following:

1. Bolt holes for bolting to equipment base.

2. Bottom steel plates for bolting or welding to sub-base as required.

3. Unit type design molded in oil-resistant neoprene.
4. Encased in ductile steel or iron casing and capable of withstanding external forces of 
   up to 1.5 g. System to be field bolted or welded to deck with ability to resist forces of 
   1.5 g.

5. Mason Type ND isolation BR, RBA or as approved.

E. Type E: Elastomer hanger rod isolators shall incorporate the following:
   1. Molded unit type neoprene element with projecting bushing lining rod clearance hole.
   2. Neoprene element to be minimum 1 3/4" (45 mm) thick.
   3. Steel retainer box encasing neoprene mounting.
   4. Clearance between mounting hanger rod and neoprene bushing shall be minimum 
      1/8" (3 mm).
   5. Requires seismic restraint type III.
   6. Mason Type HD, or as approved.

F. Type F: Combination spring/elastomer hanger rod isolators to incorporate the following:
   1. Spring and neoprene isolator elements in a steel box retainer.
   2. Other characteristics of steel box retainer and hanger rod swing as described for Type 
      C isolators.
   3. Requires seismic restraint type III
   4. Mason Type TPC-30N, or as approved.

G. Type G: Pad type elastomer mountings to incorporate the following:
   1. 0.750" (19 mm) minimum thickness.
   2. 50 psi (345 KN/m²) maximum loading.
3. Ribbed or waffled design.
4. 0.10" (2.5 mm) deflection per pad thickness.
5. 1/16" (1.6 mm) galvanized steel plate between multiple layers of pad thickness.
6. Suitable bearing plate to distribute load.
7. Requires seismic restraint type II or III as installation requires.
8. Mason Type Super W, or as approved.

H. Type H: Pad type elastomer mountings to incorporate the following:
1. Laminated canvas duck and neoprene.
2. Maximum loading 1000 psi (6900 KN/m²).
3. Suitable bearing plate to distribute load.
4. Minimum thickness, 2" (12 mm).
5. Requires seismic restraint type II or III as installation requires.
6. Mason Type HL, or as approved.

I. Type I: Air Air Mounts: Freestanding, single or multiple, compressed-air bellows.
1. Assembly: Upper and lower steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows.
2. Maximum Natural Frequency: 3 Hz.
3. Operating Pressure Range: 25 to 100 psig
4. Burst Pressure: At least three times the manufacturer's published maximum operating pressure.
5. Leveling Valves: Minimum of 3 required to maintain leveling within plus or minus 1/8 inch (3 mm).

6. Requires seismic restraint type II

J. Restrained Air Mounts: Housed compressed-air bellows.

1. Assembly: Upper and lower steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows and spring, with angle-iron frame having vertical-limit stops and channel-section top with leveling adjustment and attachment screws.

2. Maximum Natural Frequency: 3 Hz.

3. Operating Pressure Range: 25 to 100 psig

4. Burst Pressure: At least three times the manufacturer's published maximum operating pressure.

5. Leveling Valves: Minimum of 3 required to maintain leveling within plus or minus 1/8 inch

6. Requires seismic restraint type II

2.5 EQUIPMENT BASES

A. Integral Structural Steel Base, Type B-1

1. Reinforced, as required, to prevent base flexure at start-up and misalignment of drive and driven units. Centrifugal fan bases complete with motor slide base with double adjustment bolts. Drilled for drive and driven unit mounting template.

2. Mason Type M, WF, or as approved.

B. Concrete Inertia Base, Type B-2
1. Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transfer into equipment. The base shall be complete with motor slide base with double adjustment bolts, pump base elbow supports, and complete with height saving brackets, reinforcing, equipment bolting provisions and isolators.

2. Minimum thickness of the inertia base shall be according to the following tabulation:

<table>
<thead>
<tr>
<th>Motor Size (hp)</th>
<th>Minimum Thickness (in.)</th>
<th>Minimum Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-15</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>20-50</td>
<td>8</td>
<td>200</td>
</tr>
<tr>
<td>60-75</td>
<td>10</td>
<td>250</td>
</tr>
<tr>
<td>100-250</td>
<td>12</td>
<td>300</td>
</tr>
<tr>
<td>300-500</td>
<td>18</td>
<td>350</td>
</tr>
</tbody>
</table>

3. Mason Type K, BMK, or as approved.

C. Curb Mounted Base, Type B-3

1. Curb mounted rooftop equipment shall be mounted on spring isolation curbs that directly sit on roof construction and are flashed and incorporated into roof's membrane waterproofing system.

2. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal.

3. All spring mounts shall be as Isolator Type B.

4. Curb and spring mounting shall be capable of withstanding 110mph wind and 1.5 g seismic loads.

5. Curbs shall be Mason Type CMAB or RSC (depending on deflection required), or approved equal.

D. Vane axial Fan Built-Up Casing Floating Base, Type B-5
1. The vane axial fan casing, coils, filter assembly and inlet/discharge silencers shall be erected on top of a poured-in-place, reinforced concrete floating floor supported on Mason Industries Type EAFM 2" (50 mm) high mounting system, or as approved.

2. The mountings shall be oriented in the floating floor base for the weight and weight distribution of the supported equipment (casing, coils, filter silencers) on the floating floor.

3. The plywood form shall be Type AC exterior grade, 2" (12 mm), thick. Isolation mounts shall be 2" (50 mm), thick and shall be selected and oriented to provide deflections not exceeding 0.3" (7.5 mm) or 10 Hz frequency.

4. The fans shall be resiliently spring supported, and as described elsewhere, from concrete piers erected from the structural slab and isolated from the floating floor.

5. The design and installation of the vane axial fan built-up casing floating floor and fan isolation shall be coordinated with the vibration control vendor such that there will be no short circuit of the floating built-up casing base and the building structure.

6. Requires seismic restraint type II.

2.6 FLEXIBLE CONNECTORS

A. Elastomer Type FC-1

1. Manufactured of nylon tire cord and EPDM, both molded and cured with hydraulic presses.

2. Straight connectors to have two spheres reinforced with a molded-in external ductile iron ring between spheres.

3. Elbow shall be long radius reducing type.

4. Rated 250 psi. (1,700 KN/m²) at 170°F (77°C). Dropping in a straight line to 170 psi. (1,200 KN/m²) at 250°F (120°C) for sizes 1-1/2" to 12" (38 to 305 mm), elbows. Elbows shall be rated no less than 90% of straight connections.
5. Sizes 10" (254 mm) and 12" (305 mm) to employ control cables with neoprene end fittings isolated from anchor plates by means of 2" (12 mm) bridge bearing neoprene bushings.

6. Minimum safety factor of 4 to 1 at maximum pressure ratings.

7. Submittals to include test reports, projected life, replacement interval, compression and elongation limits.

8. Mason Types SuperFlex MFNEC, MFLRR, MFTFU, MFTNC, MFTCR, or as approved.

B. Flexible Stainless Hose, Type FC-2
   1. Braided flexible metal hose.
   2. 2" (50 mm) pipe size and smaller with male nipple fittings.
   3. 2-1/2" (62.5 mm) and larger pipe size with fixed steel flanges.
   4. Suitable for operating pressure with 4 to 1 minimum safety factor.
   5. Length as shown on drawings.
   6. Mason Type BSS, or as approved.

C. Unbraided Exhaust Hose, Type FC-3
   1. Low pressure stainless steel angularly corrugated.
   2. Fitted with flanged ends.
   3. Maximum temperature 1500□F (815□C)
   4. Mason Type SDL-RF, or as approved.

2.7 SEISMIC RESTRAINTS
A. All seismic restraints for mechanical equipment shall be capable of safely accepting 1.0 g (1.5 g for designated life safety equipment) external forces without failure, and shall maintain equipment, piping, duct and pressure reducing boxes in a captive position. Seismic restraints shall not short circuit isolation systems or transmit objectionable vibration or noise, and shall be provided on all equipment as scheduled on drawings.

B. Submit calculations by a licensed Structural or Civil Engineer substantiating that all equipment mountings and foundations and their seismic restraints can safely accept external forces of 1.0 g load for all rigidly and resiliently supported equipment, piping, and ductwork (1.5 g load for all life safety equipment) without failure and permanent displacement. Restraining all resiliently mounted piping and ductwork with cable sway bracing by Mason Industries, or approved equal.

C. Seismic Restraint Types

1. Seismic Restraint, Type I
   a. Shall comply with general characteristics of spring isolators.
   b. Shall have vertical restraints and are capable of supporting equipment at fixed elevation during equipment erection.
   c. Shall incorporate seismic snubbing restraint in all directions at specified acceleration loadings.
   d. System to be field bolted to structure with minimum capability to withstand external forces of 1.5 g.
   e. Mason Type SSIR, or as approved

2. Seismic Restraint, Type II
   a. Each corner or side seismic restraint shall incorporate minimum 5/8” (16 mm) thick pad limit stops. Restraints shall be made of plate, structural members or square metal tubing in a welded assembly, incorporating resilient pads. Angle bumpers are not acceptable. System to be field bolted to deck with 1.5 g acceleration capacity.
b. Seismic spring mountings as described above are an acceptable alternative providing all seismic loading requirements are met.

c. Mason Industries Type Z-1011, Type Z-1225, or as approved.

3. Seismic Restraint, Type III

a. Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable fastening to equipment and structure. System to be field bolted to deck or overhead structural members or deck with aircraft cable and clamps as per SMACNA guidelines.

PART 3 - EXECUTION

3.1 GENERAL VIBRATION ISOLATION REQUIREMENTS

A. Install in accordance with manufacturer's written instructions. Vibration isolators must not cause any change of position of equipment or piping resulting in piping stresses or misalignment.

B. Mechanical equipment shall be isolated from the building structure by means of noise and vibration isolators as scheduled on the drawings or within these specifications.

C. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation systems herein specified.

D. Electrical circuit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

E. The contractor shall not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.

F. Isolation mounting deflection shall be (minimum) as specified or scheduled on drawings.
G. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

H. Bring to the Architect's attention, prior to installation, any conflicts with other trades which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

I. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.

J. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.

K. Correct, at no additional cost, all installations which are deemed defective in workmanship or materials.

3.2 EQUIPMENT ISOLATION

A. Mount floor mounted equipment on 4" (100 mm) high concrete housekeeping pads over complete floor area of equipment. Mount vibration isolating devices and related inertia blocks on concrete pad. Key housekeeping pads with hair pins, as required, to be integral with structural slab. Provide approved seismic restraint anchor plates flush with top of housekeeping pad. Concrete work specified in Division 3.

3.3 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with concrete; trowel to a smooth finish.

B. Concrete shall be as follows:

1. 3000 psi.
2. 3500 psi.

3. 4000 psi.

4. Cast-in-place concrete materials and placement requirements are specified in Division 3.

C. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.

2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

6. Cast-in-place concrete materials and placement requirements are specified in Division 3.

D. Each fan and motor assembly shall be supported on a single structural steel frame. Flexible duct connections shall be provided at inlet and discharge of fan.

E. The machine to be isolated shall be supported by a structural steel frame or concrete inertia base.

F. Brackets shall be provided to accommodate the isolator. The vertical position and size of the bracket shall be specified by the isolator manufacturer.
G. The minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor shall be 1". Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".

H. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.

I. The isolators shall be installed without raising the machine and frame assembly.

J. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.

K. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators or seismic restraints.

L. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4" (6 mm).

M. Provide flexible connections between all fans and ductwork. Refer to duct accessories section.

N. When operating weight differs from installed weight, provide built-in limit stops to prevent equipment from rising when weight is removed. Stops shall not be in contact during normal operation.

O. Additional Requirements

1. Diagonal thrust restraint shall be as described for Type C hanger with the same deflection as specified for the spring mountings. The spring element shall be designed so it can be pre-set for thrust and adjusted to allow for a maximum of 1/4" (6 mm) movement at start and stop. Thrust restraints shall be attached at the centerline of thrust. Restraint shall be Mason Type WB, or as approved.
2. All piping and ductwork to be isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping or ductwork, and maintain 3/4" to 1 1/4" (20 to 32 mm) clearance around the outside surfaces. This clearance space shall be tightly packed with fiberglass (except in cases of fire smoke dampers in ducts), and caulked airtight after installation of piping or ductwork.

3. HVAC piping vertical risers larger than 2" (50 mm) in diameter shall be isolated from the building structure by means of noise and vibration isolation guides and supports.

4. Isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the structure. Hanger rods shall be aligned to clear the hanger box.

5. Isolators shall be suspended from substantial structural members, not from slab diaphragm unless specifically permitted.

6. Structural steel for cooling tower or other equipment must support the equipment without excessive deflection of the steel. The structural steel support shall not be resonant with the isolation system resonant frequencies or the driving frequencies of the supported equipment.

3.4 PIPING AND BOILER BREECHING ISOLATORS

A. All piping and boiler breeching, except fire standpipe systems, are included under this Section.

B. Installation:

1. Isolate piping and boiler breeching outside of shafts as follows:
   a. All water, steam and glycol piping and boiler breeching in machine rooms.
   b. Piping where exposed on roof.
   c. Water piping and boiler breeching within 50 ft (15 m), or 100 diameters, which ever is greater, from connected rotating equipment and pressure reducing stations.
d. All other piping shall be rigidly supported and provided with approved seismic restraints to maintain the piping in a captive position without excessive motion.

e. Do not use neoprene components on emergency generator exhaust.

2. All piping 2" (50 mm) and over located in mechanical equipment rooms, and for a minimum of fifty (50) feet (15 m) or 100 pipe diameters, whichever is greater, from connection to vibrating mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers, Type F.

3. Horizontal suspended pipe 2" (50 mm) and smaller and all steam piping shall be suspended by Type E isolator with a minimum 3/8" (9.5 mm) deflection. Water pipe larger than 2" (50 mm) shall be supported by Type F isolator with a minimum 1" (25 mm), or same static deflection as isolated equipment to which pipe connects, whichever is greater.

4. Horizontal pipe floor supported at slab shall be supported via Type B, with a minimum static deflection of 1" (25 mm) or same deflection as isolated equipment to which pipe connects, whichever is the greater.

5. Vertical riser pipe supports shall utilize Type H.

6. Vertical riser guides, if required, shall avoid direct contact of piping with building.

7. Pipe anchors, where required, shall utilize resilient pipe anchors, Mason Industries Type ADA, or equivalent, to avoid direct contact of piping with building.

8. Pipe sway braces, where required, shall utilize two (2) neoprene elements (Type G or H to accommodate tension and compression forces).

9. Pipe extension and alignment connectors: Provide connectors at riser takeoffs, cooling and heating coils, and elsewhere as required, to accommodate thermal expansion and misalignment.

10. Adjust, as required, all isolators to eliminate all contact of the isolated rod with the hanger rod box retainer or short circuiting of the spring.
C. Domestic Water System Isolation:

1. Support all domestic water piping in horizontal and vertical runs with a resilient wrapping or clamp system employing a resilient element of wool, felt, neoprene, or other suitable material; "Trisolators" by Semco or P.R. Isolators by Potter-Roemer, or as approved.

2. All domestic water piping, size 2" and larger within the building shall be isolated as follows:
   a. Provide Type F hanger rod isolators with a minimum static deflection of 1" (25 mm) or as scheduled.
   b. Provide Type B isolators with 1" static deflection, or as scheduled.
   c. Support water piping in shafts and floor supports entering shaft with Type G isolators or Type H pad to prevent direct contact of piping with building structure.
   d. Guide and anchor piping in shafts, as required, with approved mounting designs incorporating Type H pad to prevent direct contact of pipe with building structure.

D. Isolator Position:

1. Close to building structure.
2. Between building structure and supplementary steel if required.
3. Suspend isolators from rigid and massive support points.
4. All supplementary steel to be sized for a maximum deflection of 0.08 inches (2 mm) at center span.

3.5 GENERAL SEISMIC RESTRAINT REQUIREMENT
A. All equipment whether isolated or not shall be bolted to structure to allow for minimum 1.0 g of acceleration (1.5 g for life safety equipment). Bolt points and diameter of inserts shall be submitted and verified as part of the contractor's submission for each piece of equipment and stamped and sealed by a civil or structural engineer.

B. Position all corner or side seismic restraints with equipment at operating weight for proper operation clearance and weld or bolt seismic restraint to seismic anchor plates in housekeeping pad. Install equipment with flexibility in wiring connection. Verify all installed isolators and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit startup equipment lateral motion to 1/4 inch. Prior to startup, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators or seismic restraints.

C. All suspended equipment, whether isolated or not, shall be seismically restrained at four points with Type III cable restraints.

D. Install seismic restraining system Type III taut for overhead suspended unisolated equipment, piping or ductwork, and slack with 2" (12 mm) cable deflection for isolated systems.

E. Seismically restrain all piping and ductwork with center bracing or Type III restraining system in accordance with SMACNA guidelines to comply with the UBC 1988 State of California with 1989 Amendments as outlined below:

1. All schedule 10, 20, or 40 piping shall be welded or laterally braced at 40 foot intervals and at turns of more than 4 feet. Longitudinally bracing shall be supplied at 80 foot intervals. No-hub piping shall be braced at 10 foot intervals or at 40 foot intervals if 1.5 g rated couplings are used.

2. Ductwork to be braced every 30 feet and at every turn and duct run ends. Longitudinal bracing to be provided at 60 foot intervals.

F. Seismic restraints are not required for the following:

1. Gas piping less than 1" (25 mm) internal diameter.

2. Piping in boiler and MER room that is less than 1 1/4" internal diameter. Less than 1 inch for fuel oil piping.
3. All other piping and electrical conduit less than 2" internal diameter.
4. All rectangular ducts less than 6 sq. ft. in cross sectional area.
5. All round ducts less than 28" in diameter.
6. All piping suspended by individual hangers 12" in length or less from the top of the pipe to the bottom of the support for the hanger.
7. All ducts suspended by hangers 12" or less in length from the point of the attachment to the duct to the bottom of the support for the hanger.

G. Chimneys and stacks passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps or approved vibration isolation systems with seismic restraints.

H. Chimneys and stacks running horizontally to be braced every 30 ft with Type III restraining system.

I. Where base anchoring is insufficient to resist seismic forces, supplementary restraining such as seismic restraint system Type III shall be used above system’s center of gravity to suitably resist "g" force levels. Vertically mounted tanks may require this additional restraint.

J. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:
   1. upper flanges of structural beams;
   2. upper truss chords in bar joist construction at the panel points;
   3. cast-in-place inserts or drilled and shielded inserts in concrete structures suitably located away from edges.

K. Each seismic restraint and snubbing device shall be installed after equipment is installed and fully operational. Each isolation mounting incorporating seismic restraint shall be adjusted to provide the minimum operating clearance in all directions to permit the operation of the equipment without objectionable noise or vibration to any part of the building structure. The
operating clearance for equipment seismic restraints shall not be greater than 1/4". Seismic restraints must not result in short-circuiting of isolated equipment.

L. Pipe risers through cored holes in structure require no additional seismic bracing. (Cored hole diameter to be a maximum of 2 inches larger than pipe outer diameter).

3.6 INSPECTION

A. On completion of installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representatives final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

B. Air-Mounting System Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping connections. Report results in writing.

1. Isolator seismic-restraint clearance.
2. Isolator deflection.
3. Snubber minimum clearances.
4. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
5. Operational Test: Test the compressed-air leveling system. Remove malfunctioning units, replace with new units, and retest.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.7 VIBRATION TESTING
A. Vibration testing will be performed after the equipment is installed, aligned, dynamically balanced and commissioned. The mechanical contractor shall correct any deficiencies found with the new equipment as identified in the vibration analysis report. The vibration testing shall be as follows:

1. Equipment Vibration testing shall be performed by a certified vibration consultant. A report shall be provided indicating all of the pieces of equipment tested, the results of the tests and any deficiencies found.

2. Vibration allowances shall be as per the latest ASHRAE standard for rotating equipment (ASHRAE 2000 Systems and Equipment), as defined here:

3. Vibration shall not exceed 0.20 inches per second (0.20 in/sec), peak value throughout the operating range of the piece of rotating equipment. (If connected to a VFD.)

4. Measurements for all equipment, at each point shall be taken at each axis (3 axis) throughout the entire operating range of the equipment. (If connected to a VFD.)

5. Provide critical frequency lockouts for variable frequency drives systems. Critical frequencies are to be analyzed and programmed out of the drive with a finalized report of the critical speeds removed.

6. The test for equipment connected and driven by a variable frequency drive shall include natural critical speed testing. Measurements shall be taken throughout the operating range of the equipment starting from a complete stop, ramping slowly up to maximum speed and pausing briefly at electrical and mechanical natural frequencies of the equipment / VFD from 0 to 60 hz. Program critical frequencies into the vfd onsite and provide a detailed report of the critical speed data.

B. Tests for any piece of equipment not driven by a VFD shall be at their normal operating speed, under normal operating conditions.

3.8 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.
3.9 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 23 Section HVAC General Provisions or to Division 1 Section “Closeout Procedures Demonstration and Training.”

3.10 **VIBRATION ISOLATION AND SEISMIC RESTRAINT SCHEDULE**

The following Vibration Isolation Schedule is designed for mechanical rooms on intermediate structural slabs with spans of 20 to 30 feet and minimum slab construction of 6” above any metal deck. For longer spans or lighter floors greater deflections are required consultant acoustical consultant. For slabs on grade, less isolation may be needed.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Horsepower and Other</th>
<th>RPM</th>
<th>Base Type</th>
<th>Isolator Type</th>
<th>Min. Defl., in.</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigeration Machines &amp; Chillers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reciprocating</td>
<td>All</td>
<td>All</td>
<td>–</td>
<td>B</td>
<td>1.50</td>
<td>2,3,12</td>
</tr>
<tr>
<td>Centrifugal, screw</td>
<td>All</td>
<td>All</td>
<td>–</td>
<td>B</td>
<td>1.50</td>
<td>2,3,4,12</td>
</tr>
<tr>
<td>Open centrifugal</td>
<td>All</td>
<td>All</td>
<td>B-2</td>
<td>B</td>
<td>1.50</td>
<td>2,3,12</td>
</tr>
<tr>
<td>Absorption</td>
<td>All</td>
<td>All</td>
<td>–</td>
<td>B</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>Air Compressors &amp; Vacuum Pumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tank-mounted horizontal</td>
<td>Up to 10</td>
<td>All</td>
<td>–</td>
<td>A or C</td>
<td>1.50</td>
<td>3,15</td>
</tr>
<tr>
<td></td>
<td>15 &amp; up</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>1.50</td>
<td>3,15</td>
</tr>
<tr>
<td>Tank-mounted vertical</td>
<td>All</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
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<td>3,14,15</td>
</tr>
<tr>
<td>Base-mounted</td>
<td>All</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>1.50</td>
<td>3,14,15</td>
</tr>
<tr>
<td>Large reciprocating</td>
<td>All</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close-coupled</td>
<td>Up to 7.5</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>B-2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>10 &amp; up</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>1.50</td>
<td>16</td>
</tr>
<tr>
<td>Large in-line</td>
<td>5 to 25</td>
<td>All</td>
<td>–</td>
<td>A or C</td>
<td>1.50</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>30 &amp; up</td>
<td>All</td>
<td>–</td>
<td>A or C</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>End suction and split</td>
<td>Up to 40</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>case</td>
<td>50 to 125</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>1.50</td>
<td>10,16</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>150 &amp; up</td>
<td>All</td>
<td>B-2</td>
<td>A or C</td>
<td>2.50</td>
<td>10,16</td>
</tr>
<tr>
<td>Cooling Towers</td>
<td>All</td>
<td>Up to 300</td>
<td>–</td>
<td>B</td>
<td>4</td>
<td>5,8,18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>301 to 500</td>
<td>–</td>
<td>B</td>
<td>2.50</td>
<td>5,18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500 &amp; up</td>
<td>–</td>
<td>B</td>
<td>B-2</td>
<td>5,18</td>
</tr>
<tr>
<td>Boilers (Fire-tube)</td>
<td>All</td>
<td>All</td>
<td>B-1</td>
<td>B</td>
<td>1.50</td>
<td>4</td>
</tr>
</tbody>
</table>

### Axial Fans, Fan Heads, Cabinet Fans, Fan Sections

| Up to 22 in. diameter | All | All | A or C | 0.75 | 4,9 |
| 24 in. diameter | Up to 2 in. s.p. | Up to 300 | B-2 | A or C | 3.50 | 9 |
|      |      | 300 to 500 | C | A or C | 2.50 | 9 |
|      |      | 501 & up | B | A or C | 1.50 | 9 |
|      | 2.1 in s.p and up | Up to 300 | B-2 | A or C | 3.50 | 3,9 |
|      |      | 300 to 500 | C | A or C | 2.50 | 3,8,9 |
|      |      | 501 & up | B | A or C | 1.50 | 3,8,9 |

### Centrifugal Fans

| Up to 22 in. diameter | All | All | B-1 | A or C | 0.75 | 9,19 |
| 24 in. diameter and up | Up to 40 | Up to 300 | B-1 | A or C | 3.50 | 8,19 |
|      |      | 300 to 500 | B-1 | A or C | 2.50 | 8,19 |
|      |      | 501 & up | B-1 | A or C | 1.5 | 8,19 |
### Mechanical Vibration Isolation and Seismic Restraint Systems

#### Propeller Fans

<table>
<thead>
<tr>
<th></th>
<th>50 and up</th>
<th>300 to 500</th>
<th>501 &amp; up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 300</td>
<td>B-2</td>
<td>A or C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>300 to 500</td>
<td>B-2</td>
<td>A or C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>501 &amp; up</td>
<td>B-2</td>
<td>A or C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.50</td>
</tr>
</tbody>
</table>

#### Heat Pumps

- **Inside**
  - All
  - – A
  - 1.0
- **On Roof**
  - All
  - – B
  - 1.0

#### Condensing Units

- **Inside**
  - All
  - – A
  - 1.50
- **On Roof**
  - All
  - – B
  - 2.0

#### Packaged AH, AC, H & V units

<table>
<thead>
<tr>
<th></th>
<th>Up to 10</th>
<th>15 and up to 4 in. s.p.</th>
<th>301 to 500</th>
<th>501 &amp; up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>All</td>
<td>Up to 300</td>
<td>B-2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>301 to 500</td>
<td></td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>501 &amp; up</td>
<td>B-2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.50</td>
</tr>
</tbody>
</table>

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**AKF**

Mechanical Vibration Isolation and Seismic Restraint Systems

230548 - 30
<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Max CFM</th>
<th>Isolation Factor (A)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaged Rooftop Equipment</td>
<td>All</td>
<td>All</td>
<td>See Reference Note No: 17 5,6,8,17</td>
</tr>
<tr>
<td>Ducted Rotating Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small fans, fan-powered boxes</td>
<td>Up to 600 cfm</td>
<td>All</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>601 cfm &amp; up</td>
<td>All</td>
<td>–</td>
</tr>
<tr>
<td>Engine-Driven Generators</td>
<td>All</td>
<td>All</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.50 2,3,4</td>
</tr>
</tbody>
</table>

END OF SECTION 230548

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SECTION 230549 – Noise Control And Acoustical Performance

PART 1 - GENERAL

1.1 SUMMARY

A. It is the objective of this Specification to provide the necessary design requirements for the noise control measures and acoustical performance criteria for mechanical systems.

Work in this section includes the providing of labor, materials, equipment and services necessary for a complete installation of sound control for every mechanical system including piping and ductwork within and on the roof of the building, complete, as shown and specified per the contract documents and all applicable codes and authorities having jurisdiction for the following:

1. Sound attenuating units
2. Sound linings
3. Soundproofing of construction
4. External soundproofing

B. Related section include the following:

5. Vibration Isolation and Seismic Restraints, Section 230548.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in sound trap construction with five years minimum experience.

B. Acoustical Criteria:

   a. Noise levels due to equipment and ductwork shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to noise Criteria (NC) curves as follows:
### New York Presbyterian Hospital
#### Engineering Design Standards
March, 2015

<table>
<thead>
<tr>
<th>All spaces</th>
<th>NC-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Except below:</td>
<td></td>
</tr>
<tr>
<td>Conference Rooms</td>
<td>NC-35</td>
</tr>
<tr>
<td>Auditorium</td>
<td>NC-30</td>
</tr>
<tr>
<td>Video-Conference Rooms</td>
<td>NC-30</td>
</tr>
<tr>
<td>Lobbies, Toilets, Corridors, Computer Terminal Rooms, Laboratories (without fume hoods), Retail Tenant Spaces, Spaces within 10 feet of duct penetration through floor and walls of fan rooms</td>
<td>NC-45</td>
</tr>
<tr>
<td>Storage, Locker Rooms</td>
<td>NC-50</td>
</tr>
<tr>
<td>Kitchen, Laundry, Computer Rooms</td>
<td>NC-50</td>
</tr>
<tr>
<td>Laboratories with fume hoods</td>
<td>NC-55</td>
</tr>
<tr>
<td>Garage</td>
<td>NC-60+</td>
</tr>
</tbody>
</table>

### C. MECHANICAL EQUIPMENT ACOUSTICAL DESIGN PERFORMANCE

1. Air Distribution System:
   a. Pressure Reducing Device Noise: Maximum permissible sound-power levels in octave bands of airborne transmission through the combination of grille, registers, diffusers, and terminal units or related pressure reducing devices, when operated at the maximum inlet pressure and cfm in installed condition per plans and specifications shall be as follows:

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>NC-30</th>
<th>NC-35</th>
<th>NC-40</th>
<th>NC-45</th>
<th>NC-50+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>58</td>
<td>62</td>
<td>66</td>
<td>68</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>56</td>
<td>60</td>
<td>63</td>
<td>66</td>
</tr>
</tbody>
</table>

**AIR DISTRIBUTION SYSTEM EQUIPMENT/Terminal Device Noise**

MAX PWL (dB re 10^-12 Watt)
2. Pressure reducing valve radiated noise, including VAV and Fan Powered Boxes.
   a. Maximum permissible radiated sound-power levels in octave bands of pressure reducing valves when operated at the maximum inlet pressure and air quantity in an installed condition over occupied spaces shall be as follows:

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>NC-35</th>
<th>NC-40</th>
<th>NC-45</th>
<th>NC-50+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72</td>
<td>76</td>
<td>79</td>
<td>82</td>
</tr>
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<td>2</td>
<td>70</td>
<td>74</td>
<td>77</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>61</td>
<td>65</td>
<td>68</td>
<td>72</td>
</tr>
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<td>4</td>
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<td>6</td>
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</tr>
<tr>
<td>7</td>
<td>66</td>
<td>70</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>8</td>
<td>65</td>
<td>70</td>
<td>75</td>
<td>80</td>
</tr>
</tbody>
</table>

3. Fan Powered Box Test Requirements
   a. A written test report for each size unit to be used on the project shall be submitted including the radiated and discharge sound power levels in octave bands of each type and size fan powered box installed in a reverberant room with the unit operated at maximum air flow and an inlet pressure of 1.5" wg and discharge pressure of 0.3" wg. The ductwork connected to the test unit shall be installed without any sound barrier lagging within 10'-0" upstream or downstream of the box.
   b. The maximum permissible radiated sound-power levels in octave bands shall not exceed the following:
c. The project criterion of NC-35 for private offices and NC-40 for all other spaces over which the box is located shall be certified at the design air flow rate and 1.5"w.g. inlet pressure and 0.3"w.g. discharge pressure.

d. The manufacturer shall, in addition to meeting the above sound power limits, test or provide substantiating data showing that all units have been tested in a mock-up office ceiling plenum. The mock-up office test shall be representative of the project conditions in terms of:

1) Ceiling plenum depth and project ceiling type and ceiling grid type.

2) Light fixtures and return air provisions. (NOTE: For worst-case scenario, the light fixture and/or return air grille shall be located directly below the unit.)

3) Project inlet and discharge ductwork (i.e., hard ductwork).

4) Mock-up office walls shall terminate at the slab above, unless the project conditions indicate otherwise.

e. The units shall be tested at the maximum design air flow rates and specified inlet pressures of 1.5" wg and downstream pressure of 0.3" w.g.

f. The NC requirements shall be certified at maximum design air flow rates and 1.5" wg inlet pressure and 0.3"wg discharge pressure.

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>NC-35</th>
<th>NC-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72</td>
<td>76</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>74</td>
</tr>
<tr>
<td>3</td>
<td>61</td>
<td>65</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>57</td>
<td>62</td>
</tr>
<tr>
<td>6</td>
<td>56</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>66</td>
<td>70</td>
</tr>
<tr>
<td>8</td>
<td>65</td>
<td>70</td>
</tr>
</tbody>
</table>
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- g. A written report of measured radiated sound pressure levels measured directly below the units shall be submitted, certifying that the unit, when operating at the design flow and inlet pressure, will permit achieving an NC environment in accordance with the established criteria in occupied spaces below the boxes.

- h. Any failure to meet the project requirements causing retesting shall be done so at the expense of the manufacturer (including architects, mechanical engineers and acoustical consultants' time and expenses).

4. Acoustical Performance Within Equipment Spaces: Equipment room noise levels and noise transmission to adjacent buildings shall comply with all Federal, State and City Noise Ordinances.

5. Motor Acoustical Performance:

- a. Motor drives for pumps and refrigeration machine, when installed per plans and specifications, shall operate with noise levels not exceeding 90 dB(A).

- b. Noise levels shall be determined in accordance with IEEE Standard #85 Test "Procedure for Airborne Noise Measurements on Rotating Electric Equipment."

6. Refrigeration Machine Gear Train Acoustical Performance: The gear train assembly (between drive and compressor) when operating at the refrigeration machine rated capacity per plans and specifications and tested in accordance with the latest version of AGMA 295 shall have noise levels not exceeding 90 dB(A).

7. Refrigeration Machine Acoustical Performance: The maximum permissible noise levels under design operating conditions and low load conditions, when measured in accordance with the latest version of ARI Standard 575 specified methods and qualifications shall not exceed 90 dB(A).

8. Cooling Tower Acoustical Performance: The maximum permissible noise levels under design operating conditions shall be as follows:

<table>
<thead>
<tr>
<th>COOLING TOWER MAXIMUM PERMISSIBLE SOUND PRESSURE LEVELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>in dB re 20 MICROPASCALS</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Octave Band</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

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9. Boiler Acoustical Performance: Maximum permissible sound pressure level when operated under installed conditions shall be 90 dB (A) when measured in accordance with ARI Standard 575-94.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Submit data for each product indicated.

B. Sound Traps and Silencers:

1. Including certified test data of sound attenuation and self-generated flow noise.

2. For manufacturers using local sheet metal shops in lieu of their factory: Tests must be submitted for silencers manufactured by the current local Sheet Metal Shop.

C. Sound Linings:

1 Certification that sound lining meets erosion test method described in UL Publication No. 181.

2 Certification that sound lining meets ASTM standards C1071, G21 and G22.

D. Include product description, list of materials for each service, and locations.

E. Submit manufacturer's installation instructions.

F. Product quality control and test reports
PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

A. Sound Traps and Silencers:
   1. Industrial Acoustics Company
   2. United McGill Corporation
   3. Semco
   4. Vibro-Acoustics

2.2 DUCT SOUND TRAPS:

A. Available shape:
   1. Rectangular straight with splitters or baffles.
   2. Round straight with center bodies or pods.
   3. Rectangular elbow with splitters or baffles.
   4. Round elbow with center bodies or pods.
   5. Rectangular transitional with splitters or baffles.

B. Factory fabricated.
   1. Shell:
      a. Galvanized steel: minimum 22 USSG (0.85 mm).
      b. Leakproof at pressure differential of 8 inch wg
   2. Media:
b. Fuel contributed and smoke developed: maximum 20.

c. Minimum 1.5 lbs per cubic foot (24 kg/m) density glass or mineral fiber packed under 5 percent compression.

d. Filler to be inert, vermin and moisture proof.

3. Provide all required duct transition pieces and connections. Connections to match ductwork being connected to.

4. Internal Construction: Galvanized perforated steel baffles: minimum 26 USSG (0.5 mm).

5. Protective plastic film shall be provided between air stream and fill to prevent any intermingling of the airstream with the fill material.

6. Silencers for fume hoods or other hazardous exhaust systems shall have no media (packless).

7. Net Insertion Ratings: Determined by duct-to-reverberant room test method at design airflow shall be as follows:

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>IAC Type as Std</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3L</td>
<td>5</td>
<td>9</td>
<td>14</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>B</td>
<td>5L</td>
<td>7</td>
<td>13</td>
<td>21</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>C</td>
<td>7L</td>
<td>13</td>
<td>18</td>
<td>28</td>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>D</td>
<td>3MS</td>
<td>7</td>
<td>12</td>
<td>19</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>E</td>
<td>5MS</td>
<td>10</td>
<td>18</td>
<td>30</td>
<td>42</td>
<td>47</td>
</tr>
<tr>
<td>F</td>
<td>7MS</td>
<td>14</td>
<td>24</td>
<td>36</td>
<td>48</td>
<td>44</td>
</tr>
<tr>
<td>G</td>
<td>3S</td>
<td>12</td>
<td>16</td>
<td>28</td>
<td>35</td>
<td>36</td>
</tr>
<tr>
<td>H</td>
<td>5S</td>
<td>18</td>
<td>24</td>
<td>40</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>I</td>
<td>7S</td>
<td>20</td>
<td>35</td>
<td>45</td>
<td>50</td>
<td>48</td>
</tr>
</tbody>
</table>
8. Maximum self-generated noise shall be as follows:

**SOUND TRAP SELF-GENERATED NOISE AT 2000 FPM MAX PWL (dB re 10^{12} WATT) (10.2 m/sec)**

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>IAC Type as Std</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>3HL</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>K</td>
<td>5HL</td>
<td>6</td>
<td>7</td>
<td>14</td>
<td>19</td>
<td>37</td>
</tr>
<tr>
<td>L</td>
<td>3HS</td>
<td>9</td>
<td>14</td>
<td>19</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>M</td>
<td>5HS</td>
<td>13</td>
<td>19</td>
<td>26</td>
<td>35</td>
<td>44</td>
</tr>
<tr>
<td>N</td>
<td>12TXS</td>
<td>11</td>
<td>19</td>
<td>22</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>O</td>
<td>1.2TXL</td>
<td>8</td>
<td>16</td>
<td>16</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>P</td>
<td>8TXLB</td>
<td>14</td>
<td>26</td>
<td>18</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

9. Certified Tests:

a. Submit certified test data from approved laboratory for pressure drop and insertion loss ratings.

1) For square or rectangular attenuators: 24 inch x 24 inch

2) For round attenuators 24 inch diameter.

10. Certification data for pressure drop and net insertion loss based on tests of same attenuator.
11. Attenuators and tests: subject to inspection upon request of Architect or Engineer.

12. Similar to Industrial Acoustics Company (IAC).

2.3 VANE AXIAL FAN CONE/DIFFUSER SILENCER

A. Factory prefabricated.

B. Minimum gauge of galvanized steel used for solid exterior shell, perforated interior lining and perforated center cone shall be:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 35.5&quot;</td>
<td>22 (0.85 mm)</td>
</tr>
<tr>
<td>35.5&quot; to 45&quot;</td>
<td>18 (mm)</td>
</tr>
<tr>
<td>Greater than 45&quot;</td>
<td>16 (mm)</td>
</tr>
</tbody>
</table>

C. Perforated metal shall have 23% open area.

D. Filler:
   1. Flame spread: maximum 25.
   3. Inert, mildew, and vermin proof.
   4. No voids or settling.

E. Interior center cone shall be same diameter as fan hub.

F. Protective plastic film shall be provided between air stream and fill to prevent any intermingling of the airstream with the fill material.

G. Acoustical Performance: Minimum Dynamic Net Insertion Loss tested according to the latest version of ASTM E477 shall be as follows:

<table>
<thead>
<tr>
<th>Octave Band Center Frequency (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>VANE AXIAL FAN CONE/DIFFUSER SILENCER DYNAMIC INSERTION LOSS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AKF

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2.4 SOUND LINING

A. Fibrous glass.

B. Facing for low pressure duct liners.
   1. Airstream Finish: neoprene or acrylic coated 100% coverage with acrylic coating with a United States Environmental Protection Agency registered anti-microbial agent proven resistant to microbial growth per ASTM Standards G21 and G22.
   2. Stenciled NFPA 90A and 90B.

C. Facing for circular medium and high pressure duct liner: Finish: Perforated 28 percent minimum open area 24 USSG (0.7 mm) sheet metal.

D. Where lining could be exposed to weather or other sources of moisture and in medium pressure system, protective plastic film shall be provided between air stream and fill to prevent contact of the liner material with moisture. Protective plastic film shall be Tedlar, or approved, and comply with relevant flame and smoke ratings.

E. Protective plastic film shall be protected by a perforated inner sheet metal liner.

F. Minimum thickness:
   3. In ductwork less than 10 sq. ft cross section: 1 inch
   4. In ductwork greater than 10 sq. ft cross section: 2 inch
   5. In plenums: 2 inch

G. Minimum density:
   6. In ductwork: 1-1/2 lb per cu ft
   7. In plenums: 3 lb per cu ft

H. Flamespread: maximum 25.

I. Fuel contributed and smoke developed: maximum 50.

J. Suitable for duct velocity of 5000 fpm
K. Dynamic loss coefficient: maximum 1.2.

L. K Factor: maximum 0.25 BTU in/hr/deg F/sqft.

M. Noise reduction coefficient for 1 inch thick lining: minimum NRC = 0.70 when tested in accordance with ASTM C423 in Type A mounting.

N. Similar to Johns Manville Permacote Linacoustic meeting ASTM C1071.

O. Adhesive and Sealer:
   8. In conformance with NFPA 90A.
   9. Maximum fire hazard ratings; as specified in insulation.
   10. Adhesive: similar to Benjamin Foster 81-99.
   11. Sealer: similar to Johns Manville Superseal or Benjamin Foster 82-07.
   12. In conformance with ASTM C919.

2.5 FAN PLENUM ACOUSTICAL CASING PANELS

A. Factory Prefabricated.

B. 4" (100 mm) Minimum thickness.

C. Shell:
   1. Interior: minimum 22 gauge perforated galvanized steel. Perforated 23% minimum open area (3/32") diameter holes on 3/16" staggered centers
   2. Exterior: minimum 18 gauge galvanized steel.
   3. Filler:
      b. Fuel contributed and smoke development: maximum 50.
      c. Inert, mildew and vermin proof.
d. No voids or settling.

4. Acoustical Performance:
   a. Minimum sound absorption coefficients tested in accordance with ASTM C423-77 shall be as follows:

   **FAN PLENUM CASING PANELS (4"-100 mm)**
   
<table>
<thead>
<tr>
<th>Octave Band Center Frequency (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption Coefficient</td>
<td>0.89</td>
<td>1.20</td>
<td>1.16</td>
<td>1.09</td>
<td>1.01</td>
<td>1.03</td>
</tr>
</tbody>
</table>

   b. Minimum Sound Transmission Loss tested in accordance with ASTM E90-85 shall be as follows:

   **FAN PLENUM CASING PANELS (4"- 100 mm)**
   
<table>
<thead>
<tr>
<th>Octave Band Center Frequency (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission Loss (dB)</td>
<td>23</td>
<td>30</td>
<td>42</td>
<td>51</td>
<td>59</td>
<td>58</td>
</tr>
</tbody>
</table>

2.6 NON-HARDENING CAULKING:
   a. Guaranteed to be permanently elastic.
   b. Similar to Tremco Polybutene.

2.7 EXTERIOR DUCT SOUND BARRIER CONSTRUCTION:
   a. Rigid fibrous glass; 2 thick; 6 lb/cu ft, similar to Johns Manville Type 817 Board.
   b. MINIMUM 20 GA., 2-1/2" WIDE METAL STUDS.
C. DRYWALL SHEET, 5/8\((16\text{MM})\) THICK, 42 LB/\text{CU FT}\)
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Stencils.
   6. Valve tags.
   7. Warning tags.

1.2 QUALITY ASSURANCE

A. ANSI/ASME A18.1 Standard for “Pipe Labeling Requirements”.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURER

A. Seton Corp.

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Stainless steel, 0.025-inch Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   2. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   3. Fasteners: Stainless-steel rivets or self-tapping screws Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger.
lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Red .

C. Background Color: Yellow .

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws .

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS
A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.6 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, acrylic enamel < black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.7 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.8 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire
3. **Nomenclature**: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. **Color**: Yellow background with black lettering.

### 2.9 PIPE LABEL COLOR SCHEDULE:

1. **Chilled-Water Piping**:
   a. Background Color: Blue.
   b. Letter Color: Black.

2. **Condenser-Water Piping**:
   a. Background Color: Blue
   b. Letter Color: Black.

3. **Heating Water Piping**:
   a. Background Color: Red.
   b. Letter Color: Black.

4. **Refrigerant Piping**:
   a. Background Color: Yellow
   b. Letter Color: Black.

5. **Low-Pressure Steam Piping**:
   a. Background Color: Yellow.
   b. Letter Color: Black.

6. **High-Pressure Steam Piping**:
   a. Background Color: Yellow.
   b. Letter Color: Black.
7. Steam Condensate Piping:
   a. Background Color: Red.
   b. Letter Color: Black.

2.10

A. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
   e. Gas: 1-1/2 inches round.
   f. Low-Pressure Steam: 1-1/2 inches round.
   g. High-Pressure Steam: 1-1/2 inches round.
   h. Steam Condensate: 1-1/2 inches round.

2. Valve-Tag Color:
   a. Chilled Water Blue.
   b. Condenser Water: Blue
   c. Refrigerant: Yellow
   d. Hot Water Red.
   e. Gas: Yellow.
   f. Low-Pressure Steam Yellow.
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2. Identification for HVAC Piping and Equipment

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2.1 High-Pressure Steam Yellow.

2.2 Steam Condensate: Red.

3. Letter Color:

a. Chilled Water: Black
b. Condenser Water: Black
c. Refrigerant: Black.
d. Hot Water: Black.
e. Gas: Black.
f. Low-Pressure Steam: Black
g. High-Pressure Steam: Black.
h. Steam Condensate: Black

2.11 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

END OF SECTION 230553
TESTING, ADJUSTING, AND BALANCING FOR HVAC
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:
   a. Constant-volume air systems.
   b. Dual-duct systems.
   c. Variable-air-volume systems.
   d. Multizone systems.
   e. Induction-unit systems.

2. Hydronic Piping Systems:
   a. Constant-flow systems.
   b. Variable-flow systems.
   c. Primary-secondary systems.

3. Reuse and testing of existing systems

4. Steam systems.

5. HVAC equipment quantitative-performance settings.


7. Laboratory fume hood airflow balancing.

8. Exhaust hood airflow balancing.

9. Space pressurization testing and adjusting.


11. Sound level measuring.

12. Stair-tower pressurization testing and adjusting.

13. Smoke-control systems testing and adjusting.


15. Existing systems TAB.

16. Verifying that automatic control devices are functioning properly.

17. Reporting results of activities and procedures specified in this Section.
B. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

E. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

F. Sample Report Forms: Submit two sets of sample TAB report forms.

G. Warranties specified in this Section.

1.2 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB, or TABB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
c. TAB plan.
d. Work schedule and Project-site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.
1.4 APPROVED TESTING & BALANCING COMPANIES

A. The following are base bid companies:
   1. All City Testing & Balancing Corp.
   2. International Test & Balance Co.
   3. Merendino and Associates
   4. Thermal Thinkers
   5. Dome Tech
   6. Noresco

1.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems". Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

1.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer’s outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.
D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

1.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

   a. Where sufficient space in sub-main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer’s written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

1.8 PROCEDURES FOR DUAL-DUCT SYSTEMS

A. Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.

B. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate mixing-box controls and to overcome resistance in the ducts and outlets downstream from mixing box.

1. If insufficient static pressure exists, increase the airflow at the fan.

C. Test and adjust the constant-volume mixing boxes as follows:

1. Verify both hot and cold operations by adjusting the thermostat and observing the air temperature and volume changes.
2. Verify sufficient inlet static pressure before making volume adjustments.
3. Adjust mixing box to indicated airflows within specified tolerances. Measure the airflow by Pitot-tube traverse readings, totaling the airflow of the outlets; or by measuring static pressure at mixing-box taps if provided by box manufacturer.

D. Remeasure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate mixing-box controls and to overcome resistance in the ducts and outlets downstream from mixing box.

E. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume dual-duct systems, and adjust each mixing-box maximum- and minimum-airflow settings.

1.9 PROCEDURES FOR VARIABLE-AIR VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at a minimum position and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
   a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance systems similar to constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.

6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.

7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

   a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

   1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

   2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.

   3. Set terminal units at full-airflow condition.

   4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

   5. Adjust terminal units for minimum airflow.

   6. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

1.10 PROCEDURES FOR MULTIZONE SYSTEMS

   A. Set unit at full flow through the cooling coil if coil has that capacity.

   B. Adjust each zone damper to indicated airflow.
1.11 PROCEDURES FOR INDUCTION-UNIT SYSTEMS

A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.

B. Adjust each induction unit.

1.12 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems’ "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

1.13 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for
differences in gage heights. Note the point on manufacturer’s pump curve at zero flow and verify that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer’s head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer’s performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated pre-settings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems’ pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.
1.14 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

1.15 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

1.16 REUSE OF EXISTING EQUIPMENT:

A. Existing system survey
   1. Prior to start of construction, contractor to perform existing conditions survey of systems to be reused and prepare complete report indicating physical condition of units and accessories and note any repairs required beyond items included in design documents to restore equipment to a fully operational condition. Report to be submitted to engineer for review and any corrective action. Coordinate this work with any new or refurbishment work listed in the specifications or plans.
   2. Provide a unit price list to be submitted with your bid for the repair of all internal components of all equipment to be reused as well as all accessories.
   3. Upon completion of the project, the contractor shall warranty all reused equipment for one (1) year.

B. Rehabilitation of existing perimeter induction units
   1. Upon completion of construction, contractor to perform the following items to each induction unit as part of this contract work.
      a. Vacuum clean unit enclosure
      b. Clean unit lint screens
      c. Steam or nitrogen clean (contractors option) unit heating/cooling unit
      d. Clean unit primary air jet nozzles
      e. Recalibrate existing or calibrate new thermostats and associated existing and new control valves.
      f. Rebalance unit to original design air and water quantities
g. Replace existing unit thermostats and control valves as shown on plan. Provide new thermostats, valves and insulation to match base building standard where shown on plan.

C. Rehabilitation of existing perimeter fan coil units

1. Upon completion of construction, contractor to perform the following items to each fan coil unit as part of this contract work:
   a. Vacuum clean unit enclosure
   b. Clean unit lint screens
   c. Steam or nitrogen clean (contractors option) unit heating/cooling coils
   d. Clean unit fan and verify fan motor operation.
   e. Replace and/or adjust sleeves and belts.
   f. Recalibrate existing or calibrate new thermostats and associated existing and new control valves.
   g. Rebalance unit to original design air and water quantities.
   h. Replace existing unit thermostats and control valves as shown on plan. Provide new thermostats, valves and insulation to match base building standard where shown on plan.

D. Rehabilitation of existing fans.

1. Mechanical contractor shall refurbish the existing fans as indicated on the plans. Work shall include but not be limited to the following: motor and drive replacement, alignment, flexible connection replacement and field fan wheel cleaning and air balancing.

   a. Cleaning: disassemble and clean all parts. If showing oxidation, brush scale and finish with zinc compound. The fan scroll should be thoroughly cleaned of all built-up matter.
   b. Motor replacement: motor shall be replaced with a new high efficiency open drip proof type motor of the sizes as scheduled
   c. Drive replacement: provide and install new fan and motor sheaves. Provide and install new belts to accommodate these sheave changes. Motor and fan shall be aligned and belt adjusted as per the fan manufacturer’s instructions, for the new cfm and rpm as scheduled
   d. Belt guard: provide and install new belt guards. Fabricated to SMACNA and OSHA standards. Provide 3/4" diamond mesh screen welded to angle frame
and secured to fan. Construct with provisions for belt tension, bearing lubrication and tachometer reading while in place

e. Rotating assembly: test shaft and replace if necessary. Field balance assembly (statically and dynamically). Perform a full frequency spectrum analysis on the system. Install new pillow block grease lubricated bearings and lubricate before start-up.

f. Provide and install new flexible connections.

E. Reuse of existing air conditioning units (ceiling and floor mounted).

1. The contractor to clean the cooling coils with nitrogen and vacuum clean casings upon completion of construction.

2. Contractor to verify the condition and repair all components of the air conditioning unit, including coils, compressor, condenser, refrigerant circuit and accessories, fan, fan motors, controls, and any parts that are required to provide proper operation. Provide unit prices with bid of all interior components that might require replacement.

3. Verify existing air conditioning unit supporting condition to ensure that it is properly supported.

4. Provide new piping, valves, instrumentation, and controls as required for proper unit operation.

5. The following is a listing of the items which must be tested and reported on for each unit.

a. Complete check of refrigerant circuits, including:

b. Required pressure and charge

c. Refrigerant leaks

d. Compressor motor

e. Compressor amperage

f. Compressor controls

g. High/low pressure switch

h. Holding relay

i. Contactor

j. Liquid line dryer

k. Liquid line sight glass

l. Over current protection devices.

m. Evaporator fans and condenser fans (air cooled equipment)
1) Fan scroll (blade deformation)
2) Shaft alignment
3) Physical condition (dirt, debris)
4) Pulley and sheaves (if applicable)
5) Belts (if applicable)
6) Motor, nameplate, amperage
7) Vibration isolation.

n. Condenser (water cooled equipment)
   1) Pressure drop across condenser
   2) Shell and piping connections and conditions
   3) Temperature of water in and out.

o. Evaporator coils
   1) Physical inspection of fins and tubes for blockage
   2) Physical inspection of coil casing
   3) Filter condition
   4) Temperature of discharge air (db & wb)

p. Controls
q. Expansion valve
r. Condenser water regulating valves
s. All damper and actuator operation and physical condition.
t. Operate each damper to full open condition.
u. Economizer/low ambient control operation.

v. Electrical power characteristics of unit.

F. Rehabilitation of existing perimeter heating units
   1. Upon completion of construction, contractor to perform the following items to each
      steam or hot water radiation as part of this contract work.
   2. Vacuum clean unit enclosure
   3. Recalibrate existing and new control valves.
   4. Rebalance unit to original design flow quantity.
   5. Replace existing unit thermostats and control valves as shown on plan. Provide new to
      match base building standard where shown on plan.
1.17 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.
B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
C. Check the setting and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record the final setting.
D. Check the settings and operation of each safety valve. Record settings.
E. Verify the operation of each steam trap.

1.18 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.
B. Adjust water flow to within specified tolerances.
C. Measure inlet and outlet water temperatures.
D. Measure inlet steam pressure.
E. Check the setting and operation of safety and relief valves. Record settings.

1.19 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.
B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

1.20 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
7. If air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

1.21 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser-water flow rate recirculating through the cooling tower.
6. Measure cooling tower pump discharge pressure.
7. Adjust water level and feed rate of makeup-water system.
1.22 PROCEDURES FOR CONDENSING UNITS
   A. Verify proper rotation of fans.
   B. Measure entering- and leaving-air temperatures.
   C. Record compressor data.

1.23 PROCEDURES FOR BOILERS
   A. If hydronic, measure entering- and leaving-water temperatures and water flow.
   B. If steam, measure entering-water temperature and flow and leaving steam pressure, temperature, and flow.

1.24 PROCEDURES FOR HEAT-TRANSFER COILS
   A. Water Coils: Measure the following data for each coil:
      1. Entering- and leaving-water temperature.
      2. Water flow rate.
      3. Water pressure drop.
      4. Dry-bulb temperature of entering and leaving air.
      5. Wet-bulb temperature of entering and leaving air for cooling coils.
      6. Airflow.
      7. Air pressure drop.

   B. Electric-Heating Coils: Measure the following data for each coil:
      1. Nameplate data.
      2. Airflow.
      3. Entering- and leaving-air temperature at full load.
      4. Voltage and amperage input of each phase at full load and at each incremental stage.
      5. Calculated kilowatt at full load.
      6. Fuse or circuit-breaker rating for overload protection.

   C. Steam Coils: Measure the following data for each coil:
1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Refrigerant Coils: Measure the following data for each coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

1.25 PROCEDURES FOR TEMPERATURE MEASUREMENTS
A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

1.26 PROCEDURES FOR COMMERCIAL KITCHEN HOODS
A. Measure, adjust, and record the airflow of each kitchen hood. For kitchen hoods designed with integral makeup air, measure and adjust the exhaust and makeup airflow. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.

1. Install welded test ports in the sides of the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.

B. After balancing is complete, do the following:
1. Measure and record the static pressure at the hood exhaust-duct connection.
2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.

3. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results.

C. Visually inspect the hood exhaust duct throughout its entire length in compliance with authorities having jurisdiction. Begin at the hood connection and end at the point it discharges outdoors. Report findings.

1. Check duct slopes as required.
2. Verify that duct access is installed as required.
3. Verify that point of termination is as required.
4. Verify that duct air velocity is within the range required.
5. Verify that duct is within a fire-rated enclosure.

D. Report deficiencies.

1.27 PROCEDURES FOR LABORATORY FUME HOODS

A. Before performing laboratory fume hood testing, measure, adjust and record the supply airflow and airflow patterns of each supply air outlet that is located in the same room as the hood. Adjust the air outlet flow pattern to minimize turbulence and to achieve the desired airflow patterns at the face and inside the hood. Verify that adequate makeup air is available to achieve the indicated flow of the hood.

B. Measure, adjust, and record the airflow of each laboratory fume hood by duct Pitot-tube traverse with the laboratory fume hood sash in the design open position.

1. For laboratory fume hoods installed in variable exhaust systems, measure, adjust, and record the hood exhaust airflow at maximum and at minimum airflow conditions.
2. For laboratory fume hoods designed with integral makeup air, measure, adjust, and record the exhaust and makeup airflow.

C. For laboratory fume hoods that are connected to centralized exhaust systems using automatic dampers, adjust the damper controller to obtain the indicated exhaust airflow.
D. After balancing is complete, do the following:

1. Measure and record the static pressure at the hood duct connection with the hood operating at indicated airflow.

2. Measure and record the face velocity across the open sash face area. Measure the face velocity at each point in a grid pattern. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter of the opening.
   a. For laboratory fume hoods designed to maintain a constant face velocity at varying sash positions, also measure and record the face velocity at 50 and 25 percent of the design open sash position.
   b. Calculate and report the average face velocity by averaging all velocity measurements.
   c. Calculate and report the exhaust airflow by multiplying the calculated average face velocity by the sash open area. Compare this quantity with the exhaust airflow measured by duct Pitot-tube traverse. Report differences.
   d. If the average face velocity is less than the indicated face velocity, retest the average face velocity and adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity.

3. Check each laboratory fume hood for the capture and containment of smoke by using a hand-held emitting device. Observe the capture and containment of smoke flow pattern across the open face and inside the hood. Make adjustments necessary to achieve the desired results.

E. With the room and laboratory fume hoods operating at indicated conditions, perform an "as-installed" performance test of the laboratory fume hood according to ASHRAE 110. Test each laboratory fume hood(s) and document the test results.

1.28 PROCEDURES FOR EXHAUST HOODS

A. Measure, adjust, and record the airflow of each exhaust hood. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, explain why, in the report, and explain the test method used.

B. After balancing is complete, do the following:

1. Measure and record the static pressure at the hood exhaust-duct connection.
2. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to achieve optimum results.

1.29 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.

1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.

2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.

3. Test room pressurization first, then zones, and finish with building pressurization.

D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.

E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.

1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.

2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test over-pressurization and under-pressurization, and observe and report on the system's ability to revert to the set point.

3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

1.30 PROCEDURES FOR VIBRATION MEASUREMENTS

A. Use a vibration meter meeting the following criteria:
   1. Solid-state circuitry with a piezoelectric accelerometer.
   2. Velocity range of 0.1 to 10 inches per second.
   3. Displacement range of 1 to 100 mils.
   4. Frequency range of at least 0 to 1000 Hz.
   5. Capable of filtering unwanted frequencies.

B. Calibrate the vibration meter before each day of testing.
   1. Use a calibrator provided with the vibration meter.
   2. Follow vibration meter and calibrator manufacturer's calibration procedures.

C. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
   1. Turn off equipment in the building that might interfere with testing.
   2. Clear the space of people.

D. Perform vibration measurements after air and water balancing and equipment testing is complete.

E. Clean equipment surfaces in contact with the vibration transducer.

F. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.

G. Measure and record vibration on rotating equipment over 3 hp.
H. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.

1. Pumps:
   a. Pump Bearing: Drive end and opposite end.
   b. Motor Bearing: Drive end and opposite end.
   c. Pump Base: Top and side.
   d. Building: Floor.
   e. Piping: To and from the pump after flexible connections.

2. Fans and HVAC Equipment with Fans:
   a. Fan Bearing: Drive end and opposite end.
   b. Motor Bearing: Drive end and opposite end.
   c. Equipment Casing: Top and side.
   d. Equipment Base: Top and side.
   e. Building: Floor.
   f. Ductwork: To and from equipment after flexible connections.
   g. Piping: To and from equipment after flexible connections.

3. Chillers and HVAC Equipment with Compressors:
   a. Compressor Bearing: Drive end and opposite end.
   b. Motor Bearing: Drive end and opposite end.
   c. Equipment Casing: Top and side.
   d. Equipment Base: Top and side.
   e. Building: Floor.
   f. Piping: To and from equipment after flexible connections.

I. For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.

J. Inspect, measure, and record vibration isolation.

1. Verify that vibration isolation is installed in the required locations.
2. Verify that installation is level and plumb.
3. Verify that isolators are properly anchored.
4. For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.
5. Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

1.31 PROCEDURES FOR SOUND-LEVEL MEASUREMENTS

A. Perform sound-pressure-level measurements with an octave-band analyzer complying with ANSI S1.4 for Type 1 sound-level meters and ANSI S1.11 for octave-band filters. Comply with requirements in ANSI S1.13, unless otherwise indicated.

B. Calibrate sound meters before each day of testing. Use a calibrator provided with the sound meter complying with ANSI S1.40 and that has NIST certification.

C. Use a microphone that is suitable for the type of sound levels measured. For areas where air velocities exceed 100 fpm, use a windscreen on the microphone.

D. Perform sound-level testing after air and water balancing and equipment testing are complete.

E. Close windows and doors to the space.

F. Perform measurements when the space is not occupied and when the occupant noise level from other spaces in the building and outside are at a minimum.

G. Clear the space of temporary sound sources so unrelated disturbances will not be measured. Position testing personnel during measurements to achieve a direct line-of-sight between the sound source and the sound-level meter.

H. Take sound measurements at a height approximately 48 inches above the floor and at least 36 inches from a wall, column, and other large surface capable of altering the measurements.

I. Take sound measurements in dBA and in each of the 8 un-weighted octave bands in the frequency range of 63 to 8000 Hz.

J. Take sound measurements with the HVAC systems off to establish the background sound levels and take sound measurements with the HVAC systems operating.
1. Calculate the difference between measurements. Apply a correction factor depending on the difference and adjust measurements.

K. Perform sound testing at locations on Project for each of the following space types. For each space type tested, select a measurement location that has the greatest sound level. If testing multiple locations for each space type, select at least one location that is near and at least one location that is remote from the predominant sound source.

1. Private office.
2. Open office area.
3. Conference room.
4. Auditorium/large meeting room/lecture hall.
5. Classroom/training room.
6. Patient room/exam room.
7. Sound or vibration sensitive laboratory.
8. Hotel room/apartment.
9. Each space with a noise criterion of RC or NC 25 or lower.
10. Each space with an indicated noise criterion of RC or NC 35 and lower that is adjacent to a mechanical equipment room or roof mounted equipment.
11. Inside each mechanical equipment room.

1.32 PROCEDURES FOR STAIR-TOWER PRESSURIZATION SYSTEM MEASUREMENTS AND ADJUSTMENTS

A. Before testing, observe the stair tower to verify that construction is complete. Verify the following:

1. Walls and ceiling are free of unintended openings and are capable of achieving a pressure boundary.
2. Fire-stopping and sealants are installed.
3. Doors, door closers, and door gaskets are installed and adjusted.
4. If applicable, window installation is complete.

B. Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

C. Test each stair tower as a single system. If multiple fans serve a single stair tower, operate the fans together.
D. Air Balance:

1. Open the doors indicated to be open and measure, adjust, and record the airflow of each:
   a. Stair-tower fan.
   b. Air outlet supplying the stair tower.

2. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

E. Pressurization Test:

1. After air balancing is complete, perform stair-tower pressurization tests.
2. Establish a consistent procedure for recording data throughout the entire test. Set the stair-tower side of the doors as the reference point and the floor side of the doors with positive pressure when higher than the stair tower, and negative pressure when lower than the stair tower.
3. With the HVAC systems operating in their normal mode of operation and the stair-tower pressurization systems off, measure and record the following:
   a. Pressure difference across each stair-tower door with all doors in the stairwell closed.
   b. Force necessary to open each door, using a spring-type scale.

4. With the HVAC systems operating and the stair-tower pressurization system activated, perform the following:
   a. Place building HVAC systems in their normal operating mode including equipment not used to implement smoke control, such as air-handling units, toilet exhaust fans, fan coil units, and similar equipment.
   b. Measure and record the pressure difference across each stair-tower door with all doors in the stair tower closed. Adjust the stair-tower pressure relief to prevent over-pressurization.
   c. Use a spring scale to measure and record the force needed to open the door closest to the fan. With the initial door held in the open position, measure and record the pressure difference across each remaining closed stair-tower door.
   d. Open additional doors (up to the number indicated) one at a time, and measure and record the pressure difference across each remaining closed stair-tower door after the opening of each additional door.
b. Open the doors indicated to be open and measure and record the direction and velocity through each of the open doors by a traverse of every 1 sq. ft. grid of door opening.

c. Calculate the average of the door velocity measurements. Compare the average velocity to the Contract Documents and governing code requirements.

5. Repeat the pressurization tests with the smoke-control systems and the HVAC systems operating.

6. Criteria for Acceptance:

   a. The opening force on any door shall not exceed 30 lbf.
   b. Code requirements
   c. Maintain minimum 0.05 to maximum 0.15 inches w.c. differential pressure at all closed doors.

F. Operational Tests:

1. Check the proper activation of the stair-tower pressurization system(s) in response to all means of activation, both automatic and manual.

2. Verify that each initiating occurrence produces the proper system response under each of the following modes of operation:

   a. Normal.
   b. Alarm.
   d. Return to normal.

3. Verify that the smoke detector at the stair pressurization fan inlet de-energizes the fan and closes the damper at the fan.

4. If standby power is provided for stair pressurization systems, test to verify that the stair pressurization systems operate while on both normal and standby power.

5. Conduct additional tests required by authorities having jurisdiction.

G. Prepare a complete report of observations, measurements, and deficiencies.

1.33 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTING

A. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary. Verify that windows and doors are closed
and that applicable saftig, gasket, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

C. Measure, adjust, and record airflow of each smoke-control system with all fans that are a part of the system operating as intended by the design.

D. Measure, adjust, and record the airflow of each fan. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

E. After air balancing is complete, perform the following pressurization testing for each smoke-control zone in the system:

1. Verify the boundaries of each smoke-control zone.
2. With the HVAC systems in their normal mode of operation and smoke control not operating, measure and record the pressure difference across each smoke-control zone. Make measurements after closing doors that separate the zones. Make one measurement across each door. Clearly indicate the high and low pressure side of each door.
3. With the system operating in the smoke-control mode and with each zone in the smoke-control system activated, perform the following:
   a. Measure and record the pressure difference across each door that separates the smoke zone from adjacent zones. Make measurements with doors that separate the smoke zone from the other zones closed. Clearly indicate the high and low pressure side of the door. Doors that have a tendency to open slightly due to the pressure difference should have one pressure measurement made while held closed and another measurement made with the door open.
   b. Continue to activate each separate zoned smoke-control system and make pressure difference measurements.
   c. After testing a smoke zone’s smoke-control system, deactivate the HVAC systems involved and return them to their normal operating mode before activating another zone’s smoke-control system.
   d. Verify that controls necessary to prevent excessive pressure differences are functional.

F. Operational Tests:
1. Check the proper activation of each zoned smoke-control system in response to all means of activation, both automatic and manual.

2. Check automatic activation in response to fire alarm signals received from the building’s fire alarm and detection system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zoned smoke-control system occurs.

3. Check and record the proper operation of fans, dampers, and related equipment as outlined below for each separate zone of the smoke-control system.

   a. Fire zone in which a smoke-control system automatically activates.
   b. Type of signal that activates a smoke-control system, such as pull station, sprinkler water flow, or smoke detector.
   c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.
   d. Positive pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.
   e. Fan(s) "ON" as required to implement the smoke-control system. Multiple- or variable-speed fans should be further noted as "MAX. VOLUME" to verify that the intended control configuration is achieved.
   f. Fan(s) "OFF" as required to implement the smoke-control system.
   g. Damper(s) "OPEN" where maximum airflow must be achieved.
   h. Damper(s) "CLOSED" where no airflow should take place.
   i. Auxiliary functions to achieve the smoke-control system configuration such as changes or override of normal operating pressure and temperature-control set points.
   j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.

G. Conduct additional tests required by authorities having jurisdiction. Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.

H. Prepare a complete report of observations, measurements, and deficiencies.

1.34 PROCEDURES FOR INDOOR-AIR QUALITY MEASUREMENTS

A. After air balancing is complete and with HVAC systems operating at indicated conditions, perform indoor-air quality testing.
B. Observe and record the following conditions for each HVAC system:

1. The distance between the outside-air intake and the closest exhaust fan discharge, cooling tower, flue termination, or vent termination.
2. Specified filters are installed. Check for leakage around filters.
3. Cooling coil drain pans have a positive slope to drain.
4. Cooling coil condensate drain trap maintains an air seal.
5. Evidence of water damage.
6. Insulation in contact with the supply, return, and outside air is dry and clean.

C. Measure and record indoor conditions served by each HVAC system. Make measurements at multiple locations served by the system if required to satisfy the following:

1. Most remote area.
2. One location per floor.
3. One location for every 5000 sq. ft.

D. Measure and record the following indoor conditions for each location two times at two-hour intervals, and in accordance with ASHRAE 113:

1. Temperature.
2. Relative humidity.
3. Air velocity.
5. Concentration of carbon monoxide (ppm).
7. Formaldehyde (ppm).

1.35 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate drain trap.
7. Check bearings and other lubricated parts for proper lubrication.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
   4. Air balance each air outlet.

1.36 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

1.37 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

1.38 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and
problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

1.39 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

   a. Indicated versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outside-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer’s serial number.
   f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
j. Number of belts, make, and size.
k. Number of filters, type, and size.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat coil static-pressure differential in inches wg.
   g. Cooling coil static-pressure differential in inches wg.
   h. Heating coil static-pressure differential in inches wg.
   i. Outside airflow in cfm.
   j. Return airflow in cfm.
   k. Outside-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuits arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

H. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
   a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer’s serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Entering-air temperature in deg F.
   c. Leaving-air temperature in deg F.
   d. Air temperature differential in deg F.
   e. Entering-air static pressure in inches wg.
   f. Leaving-air static pressure in inches wg.
   g. Air static-pressure differential in inches wg.
   h. Low-fire fuel input in Btuh.
   i. High-fire fuel input in Btuh.
   j. Manifold pressure in psig.
   k. High-temperature-limit setting in deg F.
   l. Operating set point in Btuh.
   m. Motor voltage at each connection.
   n. Motor amperage for each phase.
   o. Heating value of fuel in Btuh.

I. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Coil identification.
   d. Capacity in Btuh.
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Airflow rate in cfm.
   i. Face area in sq. ft..
   j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
a. Heat output in Btuh.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

J. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.
K. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

L. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in deg F.
M. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

N. Packaged Chiller Reports:

1. Unit Data:
   a. Unit identification.
   b. Make and model number.
   c. Manufacturer's serial number.
   d. Refrigerant type and capacity in gal.
   e. Starter type and size.
   f. Starter thermal protection size.
   g. Compressor make and model number.
   h. Compressor manufacturer's serial number.

2. Water-Cooled Condenser Test Data (Indicated and Actual Values):
   a. Refrigerant pressure in psig.
   b. Refrigerant temperature in deg F.
   c. Entering-water temperature in deg F.
   d. Leaving-water temperature in deg F.
   e. Entering-water pressure in feet of head or psig.
   f. Water pressure differential in feet of head or psig.
3. Air-Cooled Condenser Test Data (Indicated and Actual Values):
   a. Refrigerant pressure in psig.
   b. Refrigerant temperature in deg F.
   c. Entering- and leaving-air temperature in deg F.

4. Evaporator Test Reports (Indicated and Actual Values):
   a. Refrigerant pressure in psig.
   b. Refrigerant temperature in deg F.
   c. Entering-water temperature in deg F.
   d. Leaving-water temperature in deg F.
   e. Entering-water pressure in feet of head or psig.
   f. Water pressure differential in feet of head or psig.

5. Compressor Test Data (Indicated and Actual Values):
   a. Suction pressure in psig.
   b. Suction temperature in deg F.
   c. Discharge pressure in psig.
   d. Discharge temperature in deg F.
   e. Oil pressure in psig.
   f. Oil temperature in deg F.
   g. Voltage at each connection.
   h. Amperage for each phase.
   i. Kilowatt input.
   j. Crankcase heater kilowatt.
   k. Chilled-water control set point in deg F.
   l. Condenser-water control set point in deg F.
   m. Refrigerant low-pressure-cutoff set point in psig.
   n. Refrigerant high-pressure-cutoff set point in psig.

6. Refrigerant Test Data (Indicated and Actual Values):
   a. Oil level.
   b. Refrigerant level.
   c. Relief valve setting in psig.
   d. Unloader set points in psig.
   e. Percentage of cylinders unloaded.
   f. Bearing temperatures in deg F.
g. Vane position.
h. Low-temperature-cutoff set point in deg F.

O. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Compressor make.
   e. Compressor model and serial numbers.
   f. Refrigerant weight in lb.
   g. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated and Actual Values):
   a. Inlet-duct static pressure in inches wg.
   b. Outlet-duct static pressure in inches wg.
   c. Entering-air, dry-bulb temperature in deg F.
   d. Leaving-air, dry-bulb temperature in deg F.
   e. Condenser entering-water temperature in deg F.
   f. Condenser leaving-water temperature in deg F.
   g. Condenser-water temperature differential in deg F.
   h. Condenser entering-water pressure in feet of head or psig.
   i. Condenser leaving-water pressure in feet of head or psig.
   j. Condenser-water pressure differential in feet of head or psig.
   k. Control settings.
   l. Unloader set points.
   m. Low-pressure-cutout set point in psig.
   n. High-pressure-cutout set point in psig.
   o. Suction pressure in psig.
   p. Suction temperature in deg F.
   q. Condenser refrigerant pressure in psig.
   r. Condenser refrigerant temperature in deg F.
   s. Oil pressure in psig.
   t. Oil temperature in deg F.
u. Voltage at each connection.
v. Amperage for each phase.
w. Kilowatt input.
x. Crankcase heater kilowatt.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm.
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

P. Cooling Tower or Condenser Test Reports: For cooling towers or condensers, include the following:

1. Unit Data:
   a. Unit identification.
   b. Make and type.
   c. Model and serial numbers.
   d. Nominal cooling capacity in tons.
   e. Refrigerant type and weight in lb.
   f. Water-treatment chemical feeder and chemical.
   g. Number and type of fans.
   h. Fan motor make, frame size, rpm, and horsepower.
   i. Fan motor voltage at each connection.
   j. Sheave make, size in inches, and bore.
   k. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   l. Number of belts, make, and size.
   m. Pump make and model number.
   n. Pump manufacturer's serial number.
   o. Pump motor make and frame size.
   p. Pump motor horsepower and rpm.

Use pump data in first subparagraph and associated subparagraphs below for recirculating pump in evaporative condensers, not for system used with cooling towers. For cooling towers, use pump test reports.

2. Pump Test Data (Indicated and Actual Values):

   a. Voltage at each connection.
b. Amperage for each phase.
c. Water flow rate in gpm.

3. Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
   c. Water temperature differential in deg F.
   d. Entering-water pressure in feet of head or psig.
   e. Leaving-water pressure in feet of head or psig.
   f. Water pressure differential in feet of head or psig.
   g. Water flow rate in gpm.
   h. Bleed water flow rate in gpm.

4. Air Data (Indicated and Actual Values):
   a. Duct airflow rate in cfm.
   b. Inlet-duct static pressure in inches wg.
   c. Outlet-duct static pressure in inches wg.
   d. Average entering-air, wet-bulb temperature in deg F.
   e. Average leaving-air, wet-bulb temperature in deg F.
   f. Ambient wet-bulb temperature in deg F.

Q. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Ratings.

2. Steam Test Data (Indicated and Actual Values):
   a. Inlet pressure in psig.
   b. Condensate flow rate in lb/h.
3. Primary Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
   c. Entering-water pressure in feet of head or psig.
   d. Water pressure differential in feet of head or psig.
   e. Water flow rate in gpm.

4. Secondary Water Test Data (Indicated and Actual Values):
   a. Entering-water temperature in deg F.
   b. Leaving-water temperature in deg F.
   c. Entering-water pressure in feet of head or psig.
   d. Water pressure differential in feet of head or psig.
   e. Water flow rate in gpm.

Net positive suction head is important for pumps in open circuits and for pumps handling fluids at elevated temperatures.

R. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model and serial numbers.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
   h. Required net positive suction head in feet of head or psig.
   i. Pump rpm.
   j. Impeller diameter in inches.
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.
2. Test Data (Indicated and Actual Values):
   
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

S. Boiler Test Reports:

1. Unit Data:
   
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
   f. Fuel type and input in Btuh.
   g. Number of passes.
   h. Ignition type.
   i. Burner-control types.
   j. Voltage at each connection.
   k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):
   
   a. Operating pressure in psig.
   b. Operating temperature in deg F.
   c. Entering-water temperature in deg F.
   d. Leaving-water temperature in deg F.
   e. Number of safety valves and sizes in NPS.
   f. Safety valve settings in psig.
   g. High-limit setting in psig.
   h. Operating-control setting.
i. High-fire set point.
j. Low-fire set point.
k. Voltage at each connection.
l. Amperage for each phase.
m. Draft fan voltage at each connection.
n. Draft fan amperage for each phase.
o. Manifold pressure in psig.

T. Air-to-Air Heat-Recovery Unit Reports:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. If fans are an integral part of the unit, include the following for each fan:
   a. Make and type.
   b. Arrangement and size.
   c. Sheave make, size in inches, and bore.
   d. Sheave dimensions, center-to-center, and amount of adjustments in inches.

4. Test Data (Indicated and Actual Values):
   a. Total exhaust airflow rate in cfm.
   b. Purge exhaust airflow rate in cfm.
   c. Outside airflow rate in cfm.
   d. Total exhaust fan static pressure in inches wg.
e. Total outside-air fan static pressure in inches wg.

f. Pressure drop on each side of recovery wheel in inches wg.

g. Exhaust air temperature entering in deg F.

h. Exhaust air temperature leaving in deg F.

i. Outside-air temperature entering in deg F.

j. Outside-air temperature leaving in deg F.

k. Calculate sensible and total heat capacity of each airstream in MBh.

U. Vibration Measurement Reports:

1. Date and time of test.
2. Vibration meter manufacturer, model number, and serial number.
3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
4. Diagram of equipment showing the vibration measurement locations.
5. Measurement readings for each measurement location.
7. Description of predominant vibration source.

V. Sound Measurement Reports: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:

1. Date and time of test. Record each tested location on its own NC curve.
2. Sound meter manufacturer, model number, and serial number.
3. Space location within the building including floor level and room number.
4. Diagram or color photograph of the space showing the measurement location.
5. Time weighting of measurements, either fast or slow.
6. Description of the measured sound: steady, transient, or tonal.
7. Description of predominant sound source.

W. Indoor-Air Quality Measurement Reports for Each HVAC System:

1. HVAC system designation.
2. Date and time of test.
3. Outdoor temperature, relative humidity, wind speed, and wind direction at start of test.
4. Room number or similar description for each location.
5. Measurements at each location.
6. Observed deficiencies.
X. Instrument Calibration Reports:

1. Report Data:

   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

PART 2 - PRODUCTS (NOT APPLICABLE)

END OF SECTION 230593
HVAC INSULATION
SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Calcium silicate.
   b. Flexible elastomeric.
   c. Mineral fiber.

2. Fire-rated insulation systems.

3. Insulating cements.

4. Adhesives.

5. Mastics.


7. Sealants.

8. Factory-applied jackets.


10. Field-applied cloths.

11. Field-applied jackets.

12. Tapes.

13. Securements.

B. Related Sections:

1. Division 23 Section "Common Works Results for HVAC."
2. Division 23 Section "HVAC Piping and Pumps."
3. Division 23 Section "Hydronic Piping."
4. Division 23 Section "Steam and Condensate Heating Piping."
5. Division 23 Section "Refrigerant Piping."
6. Division 23 Section "Internal Combustion Engine Exhaust Piping."
7. Division 23 Section "HVAC Ducts and Casings."
8. Division 23 Section "Breechings, Chimneys and Stacks."

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail attachment and covering of heat tracing inside insulation.

3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties, equipment connections, and access panels.

6. Detail application of field-applied jackets.

7. Detail application at linkages of control devices.

8. Detail field application for each equipment type.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Sample Sizes:

   b. Sheet Form Insulation Materials: 12 inches square.
   d. Sheet Jacket Materials: 12 inches square.
   e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Qualification Data: For qualified Installer, Provide a firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that
indicated for this project, whose work has resulted in construction with a record of successful in-service performance.

E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

F. Field quality-control reports.

G. Warranty

PART 2 – PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in schedule for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide the following:
   a. Industrial Insulation Group (The); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

5. Products: Subject to compliance with requirements, provide the following:
   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Owens Corning; All-Service Duct Wrap.

I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide the following:
   b. Owens Corning; High Temperature Flexible Batt Insulations.

J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:
   a. CertainTeed Corp.; Commercial Board.
b. Johns Manville; 800 Series Spin-Glas.
c. Knauf Insulation; Insulation Board.
d. Owens Corning; Fiberglas 700 Series.

K. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide the following:
   a. Johns Manville; 1000 Series Spin-Glas.
   b. Owens Corning; High Temperature Industrial Board Insulations.
   c. Roxul Inc.; Roxul RW.

L. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide the following available products that may be incorporated
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000 Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

M. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products: Subject to compliance with requirements, provide the following:
   a. Knauf Insulation; Permawick Pipe Insulation.
   b. Owens Corning; VaporWick Pipe Insulation.
N. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation. Phenolic insulation is available in Grades 1 and 2. Grade 1 has a lower thermal conductivity than Grade 2. Grade 2 is not commercially available. Grade 1 is available from only one manufacturer.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following:
   a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.
g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2. NYC projects, product to have an MEA# and listing for the particular application

2.3 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, provide the following:
      a. Insulco, Division of MFS, Inc.; Triple I.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide the following:

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Insulco, Division of MFS, Inc.; SmoothKote.
      c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
   1. Products: Subject to compliance with requirements, provide the following:
C. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide the following:

   a. Childers Products, Division of ITW; CP-96.

D. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide the following:

   a. Aeroflex USA Inc.; Aerosol.
   b. Armacell LCC; 520 Adhesive.
   c. Foster Products Corporation, H. B. Fuller Company; 85-75.
   d. RBX Corporation; Rubatex Contact Adhesive.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide the following:

   a. Childers Products, Division of ITW; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide the following:

   a. Childers Products, Division of ITW; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide the following:
   a. Dow Chemical Company (The); 739, Dow Silicone.
   e. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   a. Childers Products, Division of ITW; CP-35.
   b. Foster Products Corporation, H. B. Fuller Company; 30-90.
   c. ITW TACC, Division of Illinois Tool Works; CB-50.
   d. Marathon Industries, Inc.; 590.
   e. Mon-Eco Industries, Inc.; 55-40.
   f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.


2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, provide the following:
   a. Childers Products, Division of ITW; CP-52.
   b. Foster Products Corporation, H. B. Fuller Company; 81-42.
   c. Marathon Industries, Inc.; 130.
   d. Mon-Eco Industries, Inc.; 11-30.
   e. Vimasco Corporation; 136.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.

3. Service Temperature Range: Minus 50 to plus 180 deg F.


2.7 SEALANTS

A. Joint Sealants:

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:
a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.


2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

5. PVDC Jacket for Indoor Applications: 4-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, provide the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC Jacket for Outdoor Applications: 6-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96
and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, provide the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.


a. Products: Subject to compliance with requirements, provide the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide the following:

a. Vimasco Corporation; Elastafab 894.


1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, provide the following:
2.10 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Products: Subject to compliance with requirements, provide the following:

2.11 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide the following:
   a. Johns Manville; Zeston.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   d. Moisture Barrier for Outdoor Applications: 2.5-mil thick Polysurlyn.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Sheet and roll stock ready for shop or field sizing Factory cut and rolled to size.
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   d. Moisture Barrier for Outdoor Applications: 2.5-mil thick Polysurlyn.
   e. Factory-Fabricated Fitting Covers:
1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, provide the following:
   a. Pittsburgh Corning Corporation; Pittwrap.
   b. Polyguard; Insulrap No Torch 125.

F. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide the following:
   a. Polyguard; Alumaguard 60.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.

3. Thickness: 11.5 mils.


5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.

3. Thickness: 6.5 mils.


5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.

3. Thickness: 6 mils.


5. Elongation: 500 percent.

6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

   1. Products: Subject to compliance with requirements, provide the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      b. Compac Corp.; 120.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
      d. Venture Tape; 3520 CW.

   2. Width: 2 inches.

   3. Thickness: 3.7 mils.


   5. Elongation: 5 percent.

   6. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Products; Bands.
      b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.


B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.
   
a. Products: Subject to compliance with requirements, provide the following:

   1) AGM Industries, Inc.; CWP-1.
   2) GEMCO; CD.
   3) Midwest Fasteners, Inc.; CD.
   4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   
a. Products: Subject to compliance with requirements, provide the following:

   1) AGM Industries, Inc.; CWP-1.
   2) GEMCO; Cupped Head Weld Pin.
   3) Midwest Fasteners, Inc.; Cupped Head.
   4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   
a. Products: Subject to compliance with requirements, provide the following:
1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide the following:

1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
2) GEMCO; Press and Peel.
3) Midwest Fasteners, Inc.; Self Stick.
b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, provide the following:

      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, provide the following:

      1) GEMCO.
      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      b. Childers Products.
      c. PABCO Metals Corporation.
2.13 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

2.14 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections.

1. Inspect ductwork, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

2. Inspect field-insulated equipment, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, three locations of threaded strainers, three locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
2.15 BOILER BREECHING AND INTERNAL COMBUSTION ENGINE EXHAUST PIPING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

B. Round, concealed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

C. Rectangular, exposed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

D. Rectangular, concealed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

2.16 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
5. Flexible connectors.
7. Factory-insulated access panels and doors.

2.17 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, return-air duct insulation (in unconditioned space) shall be the following:
   1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

D. Concealed, round and flat-oval, exhaust-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

E. Concealed, rectangular, supply-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

F. Concealed, rectangular, return-air duct insulation (in unconditioned space) shall be the following:
   1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

G. Concealed, rectangular, outdoor-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density

I. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

J. Concealed, supply-air plenum insulation shall be the following:


K. Concealed, return-air plenum insulation shall be the following:


L. Concealed, outdoor-air plenum insulation (in unconditioned space) shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

M. Concealed, exhaust-air plenum insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

N. Exposed, round and flat-oval, supply-air duct insulation shall be the following:


O. Exposed, round and flat-oval, return-air duct insulation in unconditioned space) shall be the following:


P. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

Q. Exposed, round and flat-oval, exhaust-air duct insulation shall be the following:


R. Exposed, rectangular, supply-air duct insulation shall be the following:

S. Exposed, rectangular, return-air duct insulation (in unconditioned space) shall be the following:

T. Exposed, rectangular, outdoor-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

U. Exposed, rectangular, exhaust-air duct insulation shall be the following:

V. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

W. Exposed, supply-air plenum insulation shall be the following:

X. Exposed, return-air plenum insulation (in unconditioned space) shall be the following:

Y. Exposed, outdoor-air plenum insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

Z. Exposed, exhaust-air plenum insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

2.18 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor’s option.

B. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

C. Exposed, round and flat-oval, return-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

D. Exposed, rectangular, supply-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

E. Exposed, rectangular, return-air duct insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

F. Exposed, supply-air plenum insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

G. Exposed, return-air plenum insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

2.19 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor’s option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with the following:

D. Heat-exchanger (water-to-water for cooling service) insulation shall be the following:

E. Heat-exchanger (water-to-water for heating service) insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
F. Steam-to-hot-water converter insulation shall be the following:
   1. Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

G. Hot-water-to-steam converter insulation shall be the following:
   1. Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

H. Chilled-water pump insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

I. Condenser-water pump insulation shall be the following:
   1. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.

J. Dual-service heating and cooling pump insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

K. Heating-hot-water pump insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

L. Heat-recovery pump insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

M. Steam condensate pump and boiler feedwater pump insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

N. Chilled-water expansion/compression tank insulation shall be the following:

O. Condenser-water expansion/compression tank insulation shall be the following:
   1. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.

P. Dual-service heating and cooling expansion/compression tank insulation shall be the following:
HVAC Insulation

Q. Heating-hot-water expansion/compression tank insulation shall be the following:

R. Heat-recovery expansion/compression tank insulation shall be the following:
   1. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.

S. Chilled-water air-separator insulation shall be the following:

T. Condenser-water air-separator insulation shall be the following:
   1. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.

U. Dual-service heating and cooling air-separator insulation shall be the following:

V. Heating-hot-water air-separator insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

W. Heat-recovery air-separator insulation shall be the following:
   1. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.

X. Thermal storage tank (brine, water, ice) insulation shall be the following:
   1. Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

Y. Deaerator insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

Z. Steam condensate tank and receiver insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
AA. Steam flash-tank, flash-separator, and blow-off-tank insulation shall be one of the following:
   1. Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

BB. Piping system filter-housing insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

CC. Outdoor, aboveground, heated, fuel-oil storage tank insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

2.20 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor’s option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

2.21 INDOOR PIPING INSULATION SCHEDULE

A. Cold water Makeup, condensate and Equipment Drain Water below 60 Deg F:
   3. All Pipe Sizes: Insulation shall be the following:

B. Chilled Water and Brine  40 Deg F (5Deg C)
   4. NPS 1.5 and smaller: Insulation shall be the following:
   5. NPS 2 TO NPS 12: Insulation shall be the following:
   6. NPS 14 and larger: Insulation to be the followings;

C. Chilled Water and Brine above 40 Deg F (5Deg C)
   1. NPS 1.5 and smaller: Insulation shall be the following:
   2. NPS 2 TO NPS 12: Insulation shall be the following:
   3. NPS 14 and larger: Insulation to be the followings;

D. Condenser Water Supply and Return 55F to 105 F (13 to 41 deg C)
1. NPS 3 and smaller: Insulation shall be the following:

2. NPS 4 to NPS 12 and larger: Insulation shall be the following:

3. NPS 14 and larger: Insulation to be the followings;

E. Heating-Hot-Water Supply and Return, 200 Deg F and below:

1. NPS 12 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

2. NPS 14 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 3 inches thick.

F. Heating-Hot-Water Supply and Return, above 200 Deg F:

1. NPS 3/4 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches Insert thickness thick.

2. NPS 1 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches thick.

G. Steam and Steam Condensate, 350 Deg F and below:

1. NPS 3/4 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches thick.

2. NPS 1: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches thick.

3. NPS 8 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 4 inches thick.

H. Steam and Steam Condensate, above 350 Deg F:

1. NPS 3/4 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches thick.

2. NPS 1 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches thick.
I. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch thick.

J. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch thick.

K. Dual-Service Heating and Cooling, 40 to 200 Deg F:
   1. NPS 12 inches and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
   2. NPS 14 and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 3 inches thick.

L. Heat-Recovery Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

M. Hot Service Drains:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

N. Hot Service Vents:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

2.22 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Piping that is exposed to outside elements shall be heat traced. Coordinate all requirements with electrical contractor for piping lengths.

B. Cold water Makeup and Equipment Drain Water:
1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral Fiber Preformed pipe type I: 1-1/2 inch (25mm) thick

C. Chilled Water and Brine:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.

D. Condenser-Water Supply and Return:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

E. Heating-Hot-Water Supply and Return, 200 Deg F and below:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

F. Heating-Hot-Water Supply and Return, above 200 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 2 inches thick.

G. Steam and Steam Condensate, 350 Deg F and below:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 3 inches thick.

H. Steam and Steam Condensate, above 350 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 4 inches thick.

I. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 2 inches thick.

J. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be the following:
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a. Flexible Elastomeric: 2 inches thick.

K. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

L. Dual-Service Heating and Cooling:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

M. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

N. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch thick.

O. Fuel Oil Piping, Heated:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

2.23 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.

C. Condenser-Water Supply and Return, All Sizes: Cellular glass, 2 inches thick.

D. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F and below: Cellular glass, 3 inches thick.

E. Heating-Hot-Water Supply and Return, All Sizes, above 200 Deg F:

1. Calcium Silicate: 3 inches thick.
F. Steam and Steam Condensate, All Sizes, 350 Deg F and below:
   1. Calcium Silicate: 4 inches thick.

G. Steam and Steam Condensate, All Sizes, above 350 Deg F:
   1. Calcium Silicate: 5 inches thick.

H. Dual-Service Heating and Cooling, All Sizes, 40 to 200 Deg F: Cellular glass, 3 inches thick.

I. Fuel Oil Piping, All Sizes, Heated: Cellular glass, 2 inches thick.

2.24 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
   1. None.

D. Ducts and Plenums, Exposed:
   1. None.

E. Equipment, Concealed:
   1. None.

F. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. None.

G. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
   1. None.
H. Piping, Concealed:
   1. None.

I. Piping, Exposed:
   1. None.
   2. Aluminum, Smooth: 0.016 inch thick.

2.25 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor’s option.

C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. Aluminum, Smooth: 0.024 inch thick.

D. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
   1. Painted Aluminum, Smooth with 2-1/2-Inch Deep Corrugations 4-by-1-Inch Box Ribs: 0.040 inch thick.

E. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. Painted Aluminum, Smooth with Z-Shaped Locking Seam: 0.020 inch 0.024 inch thick.

F. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
   1. Painted Aluminum, Smooth with 2-1/2-Inch Deep Corrugations 4-by-1-Inch Box Ribs: 0.040 inch thick.

G. Piping, Exposed:
1. Painted Aluminum, Smooth Corrugated with Z-Shaped Locking Seam: 0.020 inch thick.

2.26 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230700
HVAC INSTRUMENTATION AND CONTROLS
SECTION 230900 - HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls. Related Sections include the following:

1. Division 13 Section “Fire Alarm” for fire and smoke detectors mounted in HVAC systems and equipment.

2. Division 15 Section “Sequence of Operation” for requirements that relate to this Section.

B. Sequence of operations shall be reviewed and approved by NYPH-OFO.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is an authorized representative of the automatic control system manufacturer for both installation and maintenance of units required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

E. All portions of the system must be of the same manufacturer and must be designed, furnished, installed, commissioned and serviced by manufacturer-approved, factory-trained employees.

F. Single source responsibility of supplier shall be the complete installation and proper operation of the BMS and control system and shall include debugging and proper calibration of each component in the entire system.
G. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

H. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

I. BMS shall comply with UL 916 PAZX and 864 UDTZ and be so listed at the time of bid.

J. System devices shall have UL 864 (UUKL smoke control) and shall be so certified at time of bid.

K. All system components shall be fault-tolerant. System shall include:

1. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency.

2. Static, transient and short-circuit protection on all inputs and outputs.

3. Protection for communication lines against incorrect wiring, static transients and induced magnetic interference.

4. Network-connected devices to be AC coupled or equivalent so that any single device failure will not disrupt or halt network communication.

5. All real time clocks and data file RAM to be battery-backed for a minimum 100 hours and include local and remote system low battery indication.

L. The BMS contractor shall be regularly engaged in the installation and maintenance of BMS systems and shall meet the following qualifications.

1. A minimum of ten (10) years of demonstrated technical expertise and experience in the installation and maintenance of BMS systems similar in size and complexity to this project.

2. A minimum of ten (10) years experience installing the control system of the manufacturer that is to be proposed.

3. Shall be a certified-to-install, direct representative of a control system manufacturer that has a minimum of ten (10) years experience producing control systems similar to that which is to be proposed.
4. A maintained service organization consisting of at least eight (8) competent servicemen, within 60 miles of the project site, for a period of not less than ten years.

5. The Bidder shall not be considered qualified to bid this project unless they can provide a list of 10 projects, similar in size and scope to this project, completed within the last four years.

6. The system manufacturer/installer shall provide an experienced project manager for this work from beginning of control installation until final completion. The project manager is responsible for direct supervision of the design, installation, start-up and commissioning of the BMS as well as attending of project meetings whenever directed by the owner, construction manager, and/or mechanical contractor. It shall not be acceptable to change the project manager after the project has begun and before final completion. If the BMS manufacturer wishes to change the project manager, the construction manager and/or owner’s representative must be notified immediately and both the new project manager and the previous project manager shall spend 3 consecutive business days together on-site performing a project management switchover. Exceptions may be allowed for small projects as determined by the construction manager and/or owner’s representative.

M. Comply with all current governing codes, ordinances, and regulations including UL, NFPA, the local Building Code, NEC, etc.

N. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability for any existing control system component including but not limited to Primary Control Panels, Secondary Control Panels, personal operator workstations, and portable operator’s terminals, to be connected and directly communicate with any new BMS system equipment without bridges, routers or protocol converters.

O. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

P. Maintenance Materials: One thermostat adjusting key.

1.3 FACILITY OPERATIONS REQUIREMENTS
A. Product Data: Include manufacturer’s technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Each control device labeled with setting or adjustable range of control.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Submittal shall include the following as a minimum:

1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, instrumentation and control devices.

2. Specification sheets of sensors, transmitters, controllers, actuators, relays, switches, and miscellaneous control devices.


4. Symbol and abbreviation list for control diagrams.

5. Details of control panel faces, including controls, instruments, and labeling.

6. Schedule of dampers including size, leakage, and flow characteristics.

7. Schedule of valves including leakage and flow characteristics, GPM, pressure drop, and CV at a minimum.

8. Pads, foundations, anchorages, supports and attachments to the building structure where required for the installation of the work shall be shown in layout and in detail with sizes, dimensions, materials and methods of construction noted.

9. All shop drawings used by field personnel for the installation of equipment shall bear an Engineer’s approval stamp.

10. Architectural floor plans indicating proposed locations of all wall-mounted devices (i.e. DDC units, control panels, sensors, thermostats, etc.) and mechanical drawings indicating proposed locations of all temperature, flow, and pressure transmitters.

C. Field quality-control test reports.

D. Operation and maintenance data
E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

1.4 WORK INCLUDED

A. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all global controllers, logic controllers, and all input/output devices. Items of work included are as follows:

1. Provide a submittal that meets the requirements below for approval.

2. Coordinate installation schedule with the mechanical contractor and general contractor.

3. Provide installation of all panels and devices unless otherwise stated.

4. Provide power for panels and control devices from a source designated by the electrical contractor.

5. Provide all low voltage control wiring for the DDC system.

6. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.

7. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.

8. Provide testing, demonstration and training as specified below.

9. Common areas shall be provided with temperature sensors without capability for display or set-point adjustment. All other thermostats shall have digital display.

B. PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

1. Siemens Building Technologies, Inc.

2. Automatic Logic (acceptable at WCMC only)
2.2 CONTROL PANELS

A. Central (Master) Control Panels: Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide multicolor graphic displays, schematically showing system being controlled.

B. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricate panels of 0.06” (1.5mm) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.


3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.

4. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

C. Alarm Panels: Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted in hinged-cover enclosure.

1. Alarm Condition: Indicating light flashes and horn sounds.

2. Acknowledge Switch: Horn is silent and indicating light is steady.

3. Second Alarm: Horn sounds and indicating light is steady.

4. Alarm Condition Cleared: System is reset and indicating light is extinguished.

5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.3 BMS SYSTEM ARCHITECTURE
A. The BMS system shall use a Client/Server architecture based on a modular PC network, utilizing industry standard operating systems, networks and protocols.

B. The system shall allow the distribution of system functions such as monitoring and control and graphical user interface etc. across the network to achieve maximum flexibility and performance.

2.4 BMS NETWORK

A. The design of the BMS shall network personal computer operator workstations, Primary Control Panels and Secondary Control Panels. The network architecture shall consist of multiple network levels. Provide a peer-to-peer Primary Network to connect the PC operator workstation(s) and all Primary Control Panels in the building for global system operation. Provide Secondary Networks to connect from each Primary Control Panel to the Secondary Control Panels of associated terminal equipment.

B. Access to system data shall not be restricted by the hardware configuration of the BMS. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.

C. The BMS design shall allow the co-existence of current and future primary control panels and personal computer operator workstations on the same primary network.

D. Primary Peer-to-Peer Network

1. All operator workstations and DDC Controllers shall directly reside on a network such that communications (i.e. ability to access, edit, modify, add, delete, back up, report, tend, restore all system point database and all programs) may be executed directly between Primary Control Panels, directly between operator workstations, and directly between Primary Control Panels and operator workstations on a token passing, peer-to-peer basis.

2. Systems that operate via polled response or other types of protocols that rely on a central processor, file server, or similar device to manage panel-to-panel or device-to-device communications shall not be acceptable.

3. All operator devices either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the primary network or the secondary network. Access to data shall be based upon logical identification of building
equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.

4. The primary network shall provide the following minimum performance:

a. Provide high-speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any Control Panel is displayed at any PC workstation, standalone alarm printer, and/or Control Panel within 5 seconds.

b. Support of any combination of Primary Control Panels and operator workstations directly connected to the primary network. A minimum of 64 devices and a maximum of 100 devices shall be supported on a single primary network.

c. Message and alarm buffering to prevent information from being lost.

d. Error detection, correction and re-transmission to guarantee data integrity.

e. Synchronization of real-time clocks between Primary Control Panels and PC operator workstations, including automatic daylight savings time corrections.

f. Provide network wiring as required to ensure total system operation and communication without interruption, even if the network wiring is open in one location.

g. The primary network shall allow the Primary Control Panels to access any data from, or send control commands and alarm reports directly to, any other Primary Control Panel or combination of controllers on the network without dependence upon a central or intermediate processing device. The Primary Control Panel shall send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device. The peer-to-peer network shall also allow any Primary Control Panel to access, edit, modify, add, delete, back up, restore all system point database and all programs.

h. The primary network shall allow the Primary Control Panels to assign password access and control priorities to each system individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control only the system that the operator is authorized for. All other systems shall not be displayed at the PC workstation or portable
terminal. Passwords and priorities for every point shall be fully programmable and adjustable.

i. Each personal computer operator workstation shall support hardwired and dial up type primary networks.

E. Secondary Network

1. This network shall connect and support stand-alone Secondary Control Panels and shall communicate bi-directionally with the primary network through Primary Control Panels for transmission of global data.

2. Secondary Control Panels shall be arranged on the secondary network in a functional relationship manner with the Primary Control Panels. For example, a VAV secondary control panel on a secondary network of a Primary Control Panel that is controlling the VAV’s corresponding AHU.

3. A maximum of 25 secondary control panels may be configured on an individual secondary network to insure adequate global data and alarm response times and future space capacity.

4. The Secondary Network shall be connected to and communicate with the Primary Control Panel independently.

F. Telecommunication Capability:

a. Provide all hardware and software to allow operators at dial-up workstation(s) the ability to perform all BMS operator workstation functions as specified herein.

b. Auto-dial/auto-answer communications shall be provided to allow any part of the BMS to communicate with remote operator workstations and/or remote terminals on an intermittent basis via voice-grade telephone lines. Auto-dial Primary Control Panels shall automatically place calls to workstations to report alarms or other significant events.

c. DDC Controllers shall be able to store a minimum of 10 phone numbers of at least 20 digits. Retry a single primary number at a fixed interval until successful.
d. The auto-dial program shall include provisions for handling busy signals, "no answers" and incomplete data transfers. Provide as a minimum 3 secondary numbers when communications cannot be established with the primary device.

e. Operators at dial-up workstations shall be able to perform all control functions, all report functions and all database generation and modification functions as described for workstations connected via the network. Routines shall be provided to automatically answer calls from remote Primary Control Panels. The fact that communications are taking place with remote Primary Control Panels over telephone lines shall be completely transparent to an operator.

f. An operator shall be able to access remote buildings by selection of any facility by its logical name. The workstation dial-up program shall store the phone numbers of each remote site, so the user shall not be required to remember or manually dial telephone numbers.

g. A PC workstation may serve as an operator device on a network, as well as a dial-up workstation for multiple auto-dial Primary Control Panels or networks. Alarm and data-file transfers handled via dial-up transactions shall not interfere with network activity nor shall network activity keep the workstation from handling incoming calls.

h. Dial-up communications shall make use of Hayes compatible modems and voice-grade telephone lines. Provide modems rated at 56Kbps.

2.5 COMMUNICATION NETWORK (CISCO TECHNOLOGY ONLY)

A. The Communication Network provided for the BMS should comply with IEEE 802.3, IEEE 802.3u IEEE802.3z. The Ethernet interface to be employed should be a combination of 100BASE-T, 100BASE-TX, 1000BASE-LX. No other brands of technology is acceptable)

B. The connection between Ethernet Switches and field 100BASE-TX hubs or field Ethernet devices, should be using electrical Category 6 UTP cable.

C. The bandwidth requirement should be analyzed by the contractor, such that predetermined bandwidth should be provided for individual systems and sub-systems, by implementing Virtual LANs techniques.
2.6 OPEN PROTOCOL ROUTER

A. Network Router should be provided to route the open protocol in controller level to 100BASE-T Ethernet. The Open Protocol Router should have SNMP (MIB!!) support, TCP/IP, UDP, DHCP, ICMP, Windows 2003, TOS, HTTP, and FTP. The open protocol router should have ability to support both peer-to-peer and master-slave network communications. The physical connection to the Ethernet should be RJ-45 with 100BASE-T.

2.7 UNINTERRUPTIBLE POWER SUPPLY

A. An Uninterruptible Power Supply (UPS) shall be provided and installed by the Contractor for each of the following devices that are powered by the BMS including; BMS primary control panel, BMS secondary control panel, operator’s workstation, printer, and field device. Each UPS shall power the device for a minimum of 30 minutes, in the case of power interruption.

B. The UPS shall consist of a battery power source, charger, AC output inverter system, and automatic load transfer circuits for a full automatic operation. The UPS shall be an on-line type. When normal AC power returns, the UPS shall transfer the load to the rectifier output. At this time, the charger shall turn on to its ‘high’ charge rate until the batteries are charged approximately 80% of their rated capacity and then automatically shall switch to its maintenance ‘sensing’ position to keep the batteries in their best full-charge condition. Battery recharge time shall not be more than three hours.

C. Each UPS shall be provided, as a minimum, with pilot lights for the following conditions: “Incoming AC Power is Available”, “UPS Ready Mode”, and “UPS in Standby Mode”. The UPS shall have the capability to hot-swap batteries without interrupting the supply of power to its users.

D. The batteries shall be of the totally enclosed nickel-cadmium type or equal. Batteries that can leak gas shall not be acceptable. There shall not be any damages should the emergency outage of line power exceed the maximum operation time of the UPS. Automatic shutdown shall occur when the UPS’ maximum duty cycle is exceeded.

2.8 PRIMARY CONTROL PANEL HARDWARE

A. Spare Capacity

1. All Primary Control Panels shall be installed with 10% spare points (of each type) and 10% spare memory capacity for future connections. The type of spare point capacity shall be in the same proportion as the implemented I/O functions of the panel, but in
no case shall there be less than two spares of each implemented I/O type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

2. Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:
   a. Expansion modules
   b. Sensor/actuator
   c. Field wiring/tubing.

B. Provide all necessary hardware for a complete operating system as required. All hardware shall reside in each Primary Control Panel. Primary Control Panels shall not be dependent upon any higher level computer or another controller for operation.

C. Each Primary Control Panel shall, at a minimum, be provided with:
   1. Appropriate NEMA rated metal enclosure.
   2. An integral real-time clock.
   4. Primary Network communication module, if needed for primary network communications.
   5. Secondary Network communication module, if needed for secondary network communications.
   6. Memory module (72MB, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial-up communications.
   7. Data collection/Data Trend module sized for 10,000 data samples.
8. Power supplies as required for all associated modules, sensors, actuators, etc.

9. Software modules as required for all sequences of operation, logic sequences and energy management routines. Relay logic is not acceptable.

10. A portable operator terminal connection port to allow the temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

11. Monitoring of the status of all HOA switches. The status of the HOA switch shall be available as a BMS data point.

12. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.

13. Auxiliary enclosure for analog output transducers, isolation relays, etc. Auxiliary enclosure shall be part of primary enclosure or mounted adjacent primary enclosure.

14. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.

15. Graduated intensity LEDs or analog indication of value for each analog output

D. The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. These override switches shall be operable whether the panel processor is operational or not. Provide HOA switch for each digital output, including spares. Provide hand/auto switch and gradual positioning potentiometer for each analog output, including spares.

E. Each Primary Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The Primary Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

F. Each Primary Control Panel shall provide battery backup to support the real-time clock and all memory and programs for a minimum of 100 hours.
G. Each Primary Control Panel shall support firmware upgrades without the need to replace hardware.

H. Each controller shall support a minimum of 3 directly connected associated secondary networks.

I. Primary control panels shall provide at least two EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator’s terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

J. Provide one primary control panel to each AHU, AC unit, primary hot water system, primary chilled water system, etc.

K. Immunity to power and noise.
   1. Controller shall be able to operate at 90% – 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
   2. Operation shall be protected against electrical noise of 5 – 120Hz and from keyed radios up to 5W at 1m (3ft).
   3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
      a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V
      b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8kV air discharge, 4kV contact
      c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1kV power
      d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
   4. Isolation shall be provided at all Primary Controller’s AC input terminals to suppress induced voltage transients consistent with:
b. UL 864 Supply Line Transients  
c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

L. Minimum Approved Primary Controllers. BMS Contractors shall furnish Primary Controllers as listed below. Providing an approved controller does not release the contractor from meeting all performance, software and hardware specifications for Primary Controllers and system operations.

2. Johnson Controls Inc., - NCM350 with DCM or DX-9100s mounted in an enclosure
3. Honeywell Excel 5000 System - Excel 500 panels.
4. User Definable

2.9 PRIMARY CONTROL PANEL SOFTWARE

A. Furnish the following applications software to form complete operating system for building and energy management as described in this specification.

B. Provide all necessary software for a complete operating system as required. All software shall reside in each Primary Control Panel. Primary Control Panels shall not be dependent upon any higher level computer or another controller for operation.

C. All points, panels and programs shall be identified by a 30 character name and a 16 character point descriptor. The same names shall be displayed at both the Primary Control Panel(s) (via portable terminal, printer or modem) and the PC operator workstation(s).

D. All digital points shall have a user-defined, two-state status indication with 8 characters minimum (e.g. Summer, Enabled, Disabled, Abnormal).

E. System Security

1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. Primary Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.

4. User Log On / Log Off attempts shall be recorded.

5. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

F. Each Primary Control Panel shall, at a minimum, be provided with software for:

1. Two-position control, proportional control, proportional plus integral control, proportional, integral, plus derivative control algorithms, all with automatic control loop tuning.

2. Limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads. Upon the resumption of power, each DDC Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

4. Priority load shedding (10 zones).

5. Energy management routines including time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start-stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating / cooling interlock, supply temperature reset, priority load shedding, and power failure restart.

6. Custom, job-specific processes defined by the user, to automatically perform calculations and special control routines and sequences of operations.
a. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

b. It shall be possible to use any system measured point data or status, any system calculated data, a result from any process or any user-defined constant in any controller in the system.

c. Any process shall be able to issue commands to points in any and all other controllers in the system.

d. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

e. The custom control programming feature shall be documented via English language descriptors.

f. Each controller shall support text comment lines in the operating program to allow for quick troubleshooting, documentation and historical summaries of program development.

g. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.

7. Generate and receive automatic and manual operator messages and advisories.

8. Comment lines for all programs.

9. Distributed, independent alarm analysis and filtering. Reporting of selected alarms during system shutdown and start-up shall be automatically inhibited. A minimum of six priority levels shall be provided for each point.

10. Automatically accumulate and store run-time hours for all digital points.

11. Automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for all analog and pulse input type points.

G. Trend data shall be stored at the Primary Control Panels and automatically uploaded to the PC workstation. Uploads shall occur based on user-defined intervals, manual commands, or
automatically when the trend buffer is 80% full. All trend data shall be available for use in any 3rd party personal computer applications located in the BMS.

H. Primary Control Panels shall be able to assign password access and control priorities to each system individually. The logon password (at any PC workstation(s) or POT) shall enable the operator to monitor, adjust and/or control only the systems, programs, primary control panel, and/or secondary control panels that the operator is authorized for. All other systems, programs, primary and secondary control panels shall not be displayed at the PC workstation, POT, or modem. Passwords and priority levels for each system, program, primary control panel and secondary control panel shall be fully programmable and adjustable.

I. Primary Control Panels shall be able to access any data from, or send control commands and alarm reports directly to, any other Primary Control Panel or combination of controllers on the network without dependence upon a central or intermediate processing device. Primary Control Panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.

J. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be
able to start programs, print, be logged in the event log, generate custom messages, and display graphics.

4. In addition to the point’s descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

   a. Each DDC Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.

5. Operator-selected alarms shall be capable of initiating a call to a remote operator device.

K. Scheduling:

1. Provide a comprehensive menu driven program to automatically start and stop designated object or group of objects in the system according to a stored time.

2. It shall be possible to define a group of objects as a custom event (i.e. meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.

3. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and stop within that group.

4. The operator shall be able to define the following information:

   a. Time, day

   b. Commands such as on, off, auto, and so forth.

   c. Time delays between successive commands.

   d. There shall be provisions for manual overriding of each schedule by an appropriate operator.

5. It shall be possible to schedule calendar-based events up to one year in advance based on the following:
a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.

b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

L. Peak Demand Limiting (PDL):

1. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.

2. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.

3. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.

4. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.

5. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.

M. Temperature-compensated duty cycling:

1. The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
2. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

N. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

O. Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.

P. Enthalpy switchover (economizer). The Primary Controller Software (BCS) shall control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point the BCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.

Q. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable.

R. Sequencing. Provide application software based upon the sequences of operation specified to properly sequence equipment.

S. Staggered Start:

1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order, in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.

2. Upon the resumption of power, each Primary Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

T. Totalization:

1. Run-Time Totalization. Primary Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
2. Consumption totalization. Primary Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.

3. Event totalization. Primary Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

U. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for all points.

1. DDC Controllers shall store point history data for selected analog and digital inputs and outputs:

   a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.

   b. Trend data shall be stored at the DDC Controllers and automatically uploaded to the workstation. Uploads shall occur based upon user-defined interval, manual command or automatically when the trend buffers are 80% full. All trend data shall be available for use in any third party personal computer applications located on the MLN.

   c. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for a minimum of 36 operator-selected PID control loops. Provide capability to view or print trend and tuning reports.

      1) The controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
2) Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation, or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

V. DDC Controllers shall automatically accumulate and store run-time hours for all digital input and output points.

W. DDC Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for all analog and digital pulse input type points.

X. DDC Controllers shall count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, and monthly basis for all points. The event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.

2.10 SECONDARY CONTROL PANEL HARDWARE

A. Each Secondary Control Panel shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each secondary control panel shall be a microprocessor-based, multi-tasking, real-time digital control processor.

B. Each Primary Controller shall be able to communicate with secondary controllers over the Secondary Network to control terminal equipment only.

C. The use of Secondary Network controllers with custom program applications to control AHU’s, water systems, etc. is not acceptable.

D. Each secondary controller shall include all point inputs and outputs necessary to perform the specified control sequences. The secondary controller shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control signals shall not be acceptable. Outputs may be utilized either for two-state, modulating, floating, or proportional control, allowing for additional system flexibility.

E. Provide a Secondary Control Panel for each of the following types of equipment (if applicable):
1. Constant Air Volume (CAV) boxes.
2. Duct-mounted reheat coils.
3. Fancoil Units.
4. Fan-Powered Variable Air Volume (VAV) Boxes.
5. Reheat Coils.
6. Supplemental AC units.
7. Variable Air Volume (VAV) Boxes.
10. Unit Ventilators.
11. Room Pressurization.
13. Other terminal equipment.

F. Each Secondary Control Panel shall, at a minimum, be provided with:

1. Appropriate NEMA rated enclosure.
3. Secondary network communications ability.
4. Power supplies as required for all associated modules, sensors, actuators, etc.
5. Input/output points as required.
6. Software as required for all sequences of operation, logic sequences, and energy management routines. Relay logic is not acceptable.
7. A portable operator terminal connection port.
8. Auxiliary enclosure for analog output transducers, isolation relays, etc. Auxiliary enclosure shall be part of primary enclosure or mounted adjacent primary enclosure.

9. Local LED status indication for each digital input and output.

10. Each controller measuring air volume shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.

11. Each controller measuring air volume shall include a differential pressure transducer.

12. SCR control of electric heaters.

13. Fan speed controller for fan powered VAV boxes.

14. Fan relay for fan powered VAV boxes and fan coil units.

G. Communication. Each controller shall perform its primary control function independent of other Secondary Network communication, or if Secondary Network communication is interrupted. Reversion to a fail-safe mode of operation during Secondary Network interruption is not acceptable.

H. Control Algorithms. The controller shall receive its real-time data from the Primary Controller time clock to insure Secondary Network continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via room sensor LCD or the portable operator’s terminal as specified herein. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.

I. Control Applications. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user’s exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

J. Calibration. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.
1. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.

K. Each Secondary Control Panel shall continuously perform self-diagnostics on all hardware and secondary network communications. The Secondary Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failure to establish communication to the system.

L. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50% of the point outputs shall be of the Universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. In lieu of Universal outputs, provide a minimum of 50% spare outputs of each type via additional point termination boards or controllers. Analog outputs shall be industry standard signals such as 24VAC floating control, allowing for interface to a variety of modulating actuators. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable.

M. Provide each secondary control panel with sufficient memory to accommodate point databases, operating programs, local alarming, and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM, and PROM, or a minimum of 72hr battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Provide uninterruptible power supplies (UPS’s) of sufficient capacities for all terminal controllers that do not meet this protection requirement. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user’s exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

N. The secondary control panels shall be powered from a 24VAC source provided by this contractor and shall function normally under an operating range of 18 – 28VAC (-25% – 17%), allowing for power source fluctuations and voltage drops. Install plenum data line and sensor cable in accordance with local code and NEC. The BMS contractor shall provide a dedicated power source and separate isolation transformer for each controller to function normally under the specified operating range. The controllers shall also function normally under ambient conditions of 32º – 122ºF (0º – 50ºC) and 10% – 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly. Power supply for the ASC must be rated at a minimum of 125% of ASC power.
consumption and shall be of the fused or current limiting type. The BMS contractor shall provide 24VAC power to the terminal units by utilizing:

1. The existing line voltage power trunk and installing separate isolation transformers for each controller.

2. Dedicated line voltage power source and isolation transformers at a central location and installing 24VAC power trunk to supply multiple ASC’s in the area.

O. Environment. The controllers shall function normally under ambient conditions of 32º – 122ºF (0º – 50º C) and 10% – 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.

P. Immunity to noise. Operation shall be protected against electrical noise of 5 – 120Hz and from keyed radios up to 5W at 1m (3ft).

2.11 SECONDARY CONTROL PANEL SOFTWARE

A. Provide all necessary software for a complete operating system as required. All software shall reside in each Secondary Control Panel. Secondary Control Panels shall not be dependent upon any higher level computer or another controller for operation.

B. Secondary control panel software configured for CAV or VAV control algorithms shall include provisions for manual and automatic calibration of attached differential pressure transducer in order to maintain stable control and insuring against drift over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 CFM air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.

C. Each secondary controller shall perform its primary control function independent of primary controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the primary control panel time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) control for all applications. All PI parameters shall be field-adjustable by the user via a portable operator’s terminal.
D. Secondary control panels shall support pressure independent terminal boxes including VAV cooling only, VAV with hot water or electric reheat, Fan-powered VAV, and Fan-powered VAV with hot water or electric reheat. All VAV box control applications shall be field-selectable such that a single controller may be used in conjunction with any of the above types of terminal units to perform the specified sequences of control. This requirement must be met in order to allow for future design and application changes and to facilitate system expansions. Controllers that require factory application changes are not acceptable.

2.12 PORTABLE OPERATOR’S TERMINAL

A. Provide two (2) portable operator’s terminals.

B. Provide one (1) POT connection port at (the security desk) to communicate with entire system.

C. The POT shall be a laptop personal computer with a minimum Intel Pentium M 2 GHz processor, 512MB SDRAM, 2MB L2 Cache, 533MHz FSB, 60GB hard drive, 3.5” floppy disk drive, 8x DVD/CD Burner (DVD +/- RW)², integrated sound, SVGA video with a minimum measurement of no less than 15.4” widescreen TFT active-matrix display (1680x1050 resolution), integrated 56K modem, an NIC (network interface card) for Ethernet Networking compatible with TCP/IP network protocols. (UTP/Fiber), 9-cell Lithium Ion battery (80Whr), carrying case, and Windows NT 4.0/Windows XP. A Celeron processor or other manufacturer’s equivalent is not acceptable.

D. The BMS contractor shall provide all cables and devices necessary to plug the POT directly into individual Primary and Secondary control panels. Provide a user-friendly, English language-prompted interface for quick access to system information.

E. The POT shall be equipped with a wireless card and shall have the ability to connect to the Wireless network anywhere in the facility. The wireless card shall support IEEE 802.11b/g specifications as well as security features such as Wi-Fi Protected Access (WPA), WEP, and 802.1x. The maximum channel speed shall be 54Mbps and there shall be full backward compatibility to 802.11b networks. All hardware and software necessary for full wireless capabilities shall be included with the POT.

F. The POT shall be equipped with a 56KBps modem (minimum) and shall have the ability to connect to the BMS over standard telephone lines from any location. The operator interface for the POT shall be identical to the operator interface of the BMS workstation. All passwords shall be the same for the POT as for the BMS operator workstation.

G. The POT shall include Microsoft Office 2003 at a minimum.
H. Functionality of the POT connected at any Primary Control Panel:

1. Logon to system using same operator passwords utilized with PC operator workstation(s) and/or remote modem(s). Each password shall “follow” operator to any device at which the operator logs on.

2. Access all network information from Primary Control Panels, if authorized by password level.

3. Backup and/or restore controller databases for all system panels, not just the controller that the portable operator’s terminal is connected to.

4. Display all point, selected point, and alarm point summaries.

5. Display all trending and totalization information.

6. Add, modify, and/or delete any existing or new system point.

7. Command, change setpoint, enable/disable any system point.

8. Program and load custom control sequences as well as standard energy management programs.

9. Acknowledge all alarms.

10. Connect to local logging and report printer.

11. Each POT shall be provided with an interactive HELP function to assist operators using POT’s.

I. Simultaneous connection of all POT’s to any control panel shall not:

1. Interrupt or interfere with normal network operation in any way.

2. Prevent alarms from being transmitted.

3. Preclude any centrally-initiated commands and/or system modification.

J. The BMS shall have the capability to connect and communicate with a minimum of four (4) portable operator’s terminals simultaneously. The four portable operators’ terminals shall be able to simultaneously perform all functions specified in this section.
2.13 POCKET PC WITH ROAMIO (ANDOVER ONLY)

A. Provide three (3) Pocket PCs with RoamIO Service Tools.

B. The Pocket PC shall have the following requirements:
   1. Operating System – Pocket PC 2003 or later with Microsoft Outlook.
   2. Minimum 1.2GHz processor.
   4. Wireless card equal to that provided for the POT.
   5. Active Sync 3.5 or greater.
   7. Cradle or synchronized cable.
   8. Portable case.
   10. USB interface for connection to a personal computer.
   11. Serial cable for connection to the RoamIO.
   12. Spare battery.
   13. Provide Dell, Hewlett Packard, or pre-approved equal.

C. The RoamIO shall have the following requirements:
   1. Infinet speed: 1200 to 19.2K baud.
5. RJ-11 to Berg Adapter.

6. RE-11 to Jack-style sensor adapter.

7. CD with software for Pocket PC.

8. Belt clip.

D. All necessary hardware and software shall be included for connection of the Pocket PC and RoamIO to the BMS.SERVER

A. Each BMS Server shall consist of the following, at a minimum:

1. Dell Pentium IV CPU (800MHz Side bus), Intel Pentium 4 Processor with HT Technology Extreme Edition 3.40GHZ with 2MB L3 Cache, 1024MB of DDR2 RAM, xUGA graphics card capable of 1280x1024 pixel resolution (or better) and 32 Bit colors, non-interlaced (70Hz or better vertical refresh rate), 12 function-key keyboard, 2-button Intellimouse pointing device, 2X Western Digital Raptor WD740GD SATA Hard Disk Drive (74GB) in a RAID 1 configuration with Promise SATA150TX4 RAID controller, 3.5" floppy disk drive. ATAPI DVD+/RW Drive, External Firewire enclosure inclusive of drive bay and 40GB ATA100 hard disk drive and online imaging software. (True Image Server 7.0 or better), and an NIC (network interface card) for Ethernet Networking compatible with TCP/IP network protocols. (UTP/Fiber).

2.15 PERSONAL COMPUTER OPERATOR WORKSTATION HARDWARE

A. Provide one workstation of equal capability. The workstations shall be located…

B. Personal computer operator workstation(s) shall be provided for command entry, information management, network alarm management, and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater fault tolerance and reliability.

C. Each workstation shall consist of the following, at a minimum:

1. Full tower case personal computer with an Intel Pentium IV 3.2 GHz processor with HT technology, 1MB Advanced Transfer Level 2 Cache, 800 MHz System Bus, 1GB RAM DDR2 type, 80GB hard drive, Diamond Stealth S120 Radeon 9550 or equal (128MB DDR/AGP 8X/VGA/DVI) Video/Graphic Card, xUGA graphics card capable of 1280x1024 pixel resolution (or better) and 32 Bit colors, 3.5" floppy disk
drive, EIDE CD-RW and DVD drives, 2-button Intellimouse, enhanced performance keyboard with 7 programmable hot keys, Windows NT 4.0/Windows XP, and an NIC (network interface card) for Ethernet Networking compatible with TCP/IP network protocols. (UTP/Fiber).

2. A Celeron processor or other manufacturer’s equivalent is not acceptable,

3. Color monitor shall be a Dell UltraSharp 1901FP (or equal) 19” Flat Panel type with height adjustable stand which allows the panel to swivel, tilt and pivot. Separate controls shall be provided for color, contrasts, and brightness. The screen shall be non-reflective. The LCD module shall be active matrix, thin film transistor (TFT) having a minimum .294mm dot pitch, 250cd/m² white luminance, 600:1 contrast ratio, and 25 ms response time. The active display area shall be a minimum horizontal dimension of 16.34 inches and vertical dimension of 23.35”. The monitor shall support a resolution of 1280 x 1024 pixels at 60 Hz, at a minimum. Monitor shall display 16.7 million colors (operator workstation display card shall accommodate this quantity of colors). Monitor shall be compatible with operating conditions of 41° – 95°F and 10%RH to 80%RH, at a minimum, and storage conditions of 14° – 140°F and 10% – 85%RH, at a minimum. Regulatory approvals shall include UL/C-UL or CSA, TUV/GS, Energy Star, CE, FCC Class B, Canadian DOC, TUV/Ergonomic, Windows XP, MPRII/MPRIII, and CE. Monitor shall have a separate TTL level sync and both positive and negative horizontal and vertical synchronization signals. The viewing angle shall be a minimum 170° vertical (Left/right 85°) and 170° horizontal (Up/down 85°). Available power supply is 120VAC at 60Hz.

D. Provide a black and white printer at each workstation for the recording of critical alarms, operator transactions, and systems reports. The printer shall have the following minimum requirements:

1. 132 column/400 character per second print speed.
2. 24 Pin, impact dot matrix technology.
3. Compressed mode option for 220 characters per line.
4. Bitmapped fonts shall include double-wide, double-high, condensed, and double strike.
5. Adjustable line spacing in 1/6” or programmable (minimum 1/350” increments).
6.  Adjustable tractor for 4-22in paper widths.

7.  96 ASCII upper and lower case character set.

8.  Rated for 10,000 power on hours mean time between failures.

9.  Maximum graphics resolution of 360x360dpi.

10.  Input buffer of 64KB.

11.  Paper feed speed of 45msec/1/6” line or 5.0” per second continuous feed.

12.  Two year warranty.

13.  Provide an EPSON LQ-570e or equal.

E.  Provide a color printer at one (1) workstation, in addition to the black and white printer, for printing of graphics and any other screen displays. The owner shall choose the workstation to be connected to the color printer. The printer shall have the following requirements at a minimum:

1.  2400x1200DPI (Dot/Inch) color print resolution.

2.  600DPI black and white print resolution.


4.  Four color mix capability to provide true color printing of screen graphics.

5.  Three built-in letter quality fonts from selectable front panel buttons.

6.  2MB memory to store complete graphics for printing.

7.  Color print speed of .3 – 3ppm.

8.  Black and white print speed of 2.9 – 12ppm.

9.  Duty cycle of 2,000.

2.16  PERSONAL COMPUTER OPERATOR WORKSTATION SOFTWARE

A.  General
1. Provide software which includes the following:

   a. Scheduling and override of building operations.

   b. Collection and analysis of historical data.

   c. Editing, programming, storage, and downloading of controller databases, programs, and parameters.

   d. Microsoft Office 2003 at a minimum.

   e. A 32-bit, multi-tasking Microsoft Windows NT 4.0/Windows XP environment that allows the user to run several applications simultaneously. Other Windows applications shall run simultaneously with the BMS software including, but not limited to, Word, Excel, Access, etc.

   f. Provide a user interface that shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.

   g. The operator shall be able to drag and drop information between applications (e.g. click on a point in the alarm screen and drag it into the dynamic trend graph screen to initiate a dynamic trend).

   h. Operator specific password access protection shall allow the user to limit workstation control, display, and data base manipulation capabilities for each object in the system. An object shall be defined as any input or output point, setpoint, system program, etc. The operator privileges shall "follow" the operator to any workstation or Primary Control Panel that the operator logs on to. Provide a minimum of 1000 passwords.

   i. Operators will be able to perform only those commands on the objects available based on their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.

   j. An audit trail report to track system object changes that shall record operator initiated actions. These actions shall include, but not be limited to, changes made by a particular person, changes made to a specific piece of equipment, and/or changes made during a designated time frame. The changes shall be printed and archived for future reference either on command or automatically, at
the operator’s option. The operator activity tracking data shall be stored in a tamper proof buffer.

k. Software shall allow the operator to perform commands including, but not limited to:

1) Start up and shutdown of equipment.
2) Setpoint adjustment.
3) Add/modify/delete time programming.
4) Enable/disable process execution.
5) Lock/unlock alarm reporting.
6) Enable/disable totalization and/or trending.
7) Override PID loop setpoints.
8) Enter temporary override schedules.
9) Define holiday schedules.
10) Change time/date.
11) Automatic daylight savings time adjustments.
12) Enter/modify analog warning and alarm limits.

l. Reporting

1) Reports shall be generated and directed to CRT displays, printers, or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
   a) A general listing of all points in the network.
   b) List of all points currently in alarm.
   c) List of all points currently in override status.
d) List of all disabled points.

e) List of all points currently locked out.

f) DDC Controller trend overflow warning

g) List all weekly schedules.

m. Scheduling

1) Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide schedules for 365 days in advance.

2) Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

3) Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all points that can be commanded residing within the zone. Each point may have a unique schedule of operation relative to the zone’s occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and rescheduling of points may be accomplished easily via the zone schedule graphic.

n. Collection and Analysis of Historical Data

1) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data shall be stored on hard disk for future diagnostics and reporting.

2) Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 6 points. Provide additional functionality to allow any trended data to be transferred directly to an
off-the-shelf spreadsheet package such as Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.

3) Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both historical and/or real-time dynamic point data. A minimum of 10 points shall be viewed simultaneously on a single graph. The user may pause the graph and take "snapshots" of screens to be stored on the hard disk for future recall and analysis. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall have the ability to be manually or automatically scaled at the user’s option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the 'Y' axis. All 'Y' axis data shall be color-coded to match the line color for the corresponding point.

4) Static graphs shall represent actual point data that has been trended and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.

5) Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.

o. Dynamic Color Graphic Displays

1) All workstation(s) shall be provided with color graphics. All workstation(s) software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.
2) Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service, and system data as required.

3) Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems, and hot water systems to optimize system performance analysis and speed alarm recognition.

4) The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.

5) Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.

6) The windowing environment of the PC operator workstation(s) shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

7) Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays via an off the shelf graphics package similar to MicroGraphix Designer.

8) Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.

9) Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points that aids the operator in the analysis of the facility.
10) Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers, PC workstation(s), and networks.

11) Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical, and/or plumbing system connected to the BMS.

12) Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.

13) Provide an additional (10) separate dynamic, graphic display pages at each workstation as required by the operating staff to further assist in daily system operations.

14) Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.

2. System Configuration and Definition

a. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

b. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete, or modify any system object including Primary Control Panel(s), operator workstation(s), Secondary Control Panels, reporting definitions, control loops, energy management applications, time and calendar-based programming, totalization, historical data trending, custom control processes, graphic displays, operator passwords, alarm messages, etc.

c. Definition of operator device characteristics for individual points, applications, and control sequences shall be performed using instructive prompting software.

d. Programming shall be performed with the BMS system online and shall not interfere with BMS system operation.
e. Inputs and outputs for any process shall not be restricted to a single Primary Control Panel, but shall be able to include data from any and all other network panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).

f. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation(s) are on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate Primary Control Panel. Similarly, changes made at the Primary Control Panels shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.

g. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

2.17 TOUCH SCREEN PANEL

A. Touch screen operator workstation shall be provided for network alarm annunciation/management. All real-time control functions shall be resident in the DDC controllers to facilitate greater fault tolerance and reliability.

B. The workstation shall consist of the following, at a minimum:

1. Touch panel computer with 1 GHz processor, 256 MB DDR SDRAM, 12” TFT color LCD screen, I/O ports – (4) serial, (1) parallel, (1) VGA, (2) USB, (3) audio, (1) PS-2, Type II PCMCIA, Type II Compact Flash Slot, PC/104 Plus X 1 Expansion slot.

2.18 INTERNET BASED COMMUNICATION

A. Web Based Operator Interface

1. The BMS shall provide a web based graphical interface that allows users to access the BMS data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BMS to a web browser.
2. A web server computer will be supplied (if required). The web server shall use Microsoft’s IIS server 4.0 with Windows NT4, or IIS 5.0 with Windows 2000, and support browser access via Microsoft Internet Explorer 5.0 (or higher), or Navigator Netscape 6.0 (or higher).

3. All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).

4. Access to the web interface shall be password protected. Users’ rights and privileges to points and graphics will be the same as those assigned at the BMS workstation. An option will exist to only allow users “read” access via the web browser, while maintaining “command” privileges via the BMS workstation.

5. The web interface shall not require modification or creation of HTML or ASP pages using an HTML editor. All graphics available at the BMS graphical workstation shall be automatically generated to a web server.

6. The web based interface shall provide the following functionality to users, based on their access and privilege rights:

   a. Logon Screen - allows the user to enter their name, password and domain name for logging into the web server.

   b. Alarm Display - a display of current BMS System alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages. Any alarm acknowledgments initiated through the web interface will be recorded to the BMS System activity log.

   c. Graphic Display - Display of system graphics, including animated motion, available in the BMS system workstation will be available for viewing over the web browser. Software that requires the creation of dedicated “web” graphics in order to display via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphics displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user account rights.
d. Point Details - users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access.

e. Point Commanding - users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BMS system central workstation activity log.

7. The web server licensing options will allow concurrent access by a minimum of five (5) browser connections.

8. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the owner as required to support the web access feature.

2.19 REMOTE NOTIFICATION PAGING SYSTEM:

A. Workstations shall be configured to send out messages to numeric pagers, alphanumeric pagers, phones (via text to speech technology), SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.

B. There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices that can receive messages from the system.

C. On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.

D. Remote devices may be scheduled as to when they receive messages from the system to account for operators' work schedules.

E. System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.

F. Message detail shall be configurable on a per user basis.

G. During a "flood" of alarms, remote notification messages shall have the ability to optimize several alarms into an individual remote notification message.
H. Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.

I. Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.

2.20 MAINTENANCE MANAGEMENT SOFTWARE

A. Furnish a fully populated (with data for HVAC equipment maintenance) Computerized Maintenance Management System (CMMS) that includes the following features:

1. Automatic Work Order Activation – which allows preventive maintenance work orders to activate automatically based on runtime or date schedules.

2. Preventive Maintenance (PM) Module – which will develop, assign, and schedule preventive maintenance; must have the ability to record thousands of schedules based on calendar and runtime scheduling. Supports multiple tasks per work order. Supports multiple pieces of equipment per work order. Supports multiple scheduling cycles (daily, weekly, monthly, annual) in a single work order.

3. Demand Maintenance (DM) Module – which creates and records maintenance jobs in response to service requests, emergency breakdowns, or other non-routine maintenance requests. Supports multiple tasks per work order. User can categorize the work completed based on a cause of failure.

4. Building Automation System Interface – must have an interface with leading HVAC and building control systems to generate work orders automatically in response to alarms or runtime totals from points monitored by the control system. Supports the BACnet (ANSI/Ashrae Standard 135-2001) and Niagara Framework protocol for HVAC control systems.

5. Equipment Module – which tracks the details of all equipment and subassemblies; must be able to record thousands of items.

6. Customer Module – supports an unlimited number of customers (or buildings) providing complete profile and record for each.

7. Scheduling – provides a visual presentation of all maintenance activity along with the capability to re-assign and re-schedule resources.
8. Time Card – add or update labor to all work orders associated with a given employee.

9. Inventory Module – with the ability to track and record all parts and supplies; must be linked with Vendors Module.

10. Purchasing Module – which will create purchase orders and/or requisitions and reorder stock.

11. Maintenance History Module – to maintain historical records of all preventive and demand maintenance performed, and build associated bills of material.

12. Reports and Graphs – must provide standard reports that can be filtered and queried to create specific versions of these reports as needed. Provide the ability to create unique graphs and reports, and modify existing reports using Crystal Reports editing tool.

13. Print/Close Work Order Options – must be able to prepare, approve, print, email and close work orders.

14. Password Protection – must be able to define an unlimited number of users, each with its own password and level of authority.

15. Rights Module – must provide method of defining and restricting the ability of users to access/read/write data of each module.

16. Barcode Module – will help the user gather runtime info, assist with inventory check in/checkout, and update labor, parts, tasks, and causes on work orders.

17. Multi-Drawing Viewer – must be able to view and print multiple AutoCAD drawings and graphics files (including JPEG, PDF, bitmaps, etc..) from Equipment, Inventory, DM Template, DM Active, PM Master, and PM Active Master files.

18. Service Request Module – allows users to request service from any workstation on the network using a simple pop up window. The request can be configured to automatically generate a work order or be reviewed by the Maintenance Manager. Requestor will automatically receive an e-mail when a work order is created and when a work order is closed.
19. Data Import Capability – ability to take existing electronic data (in tab-delimited text format) and import it into the CMMS databases.

20. PM Tasks Database – which allows the user to build preventive maintenance work orders from a predefined list of common HVAC tasks. These lists can be edited and customized to meet the specific needs of the equipment they will be assigned to.

21. Field Name Change Utility – which allows the user to modify field names throughout the software to meet specific nomenclature requirements. These new field names should carry over to reports, graphs, and purchase orders.

22. Database support – Offers selection on types of database including at least MSDE, Microsoft SQL Server and Oracle

23. Mobile PDA Support – Support of Palm OS based PDA type handheld devices in place of paper work orders.

24. Provide Proteus V Professional Maintenance Manager Software or pre-approved equal.

2.21 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10-70°F (-23-21°C), and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55% and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.22 TIME CLOCKS
A. Solid-state, programmable time control with 4 separate programs; 24hr battery carryover; individual on-off-auto switches for each program; 365 day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

2.23 SENSORS

A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Temperature Sensors

1. Resistance Temperature Detectors: Platinum. Temperature sensors shall be platinum resistance temperature detectors (RTD) with the following characteristics. Thermistor sensors are NOT an acceptable substitute, regardless of accuracy. Platinum RTDs may be installed with a transmitter if the controller cannot accept a direct platinum RTD input. It is not acceptable to claim that the controller cannot accept an RTD sensor. The project will be bid and installed with a controller that accepts RTD sensors or the voltage or current input of a platinum RTD used in conjunction with a transmitter. NO EXCEPTIONS. Thermistors used alone may be submitted as a deduct price for the owner’s consideration.

2. Accuracy: Plus or minus 0.2°F.


4. Insertion Elements in Ducts: Single point, 8” (20cm) 18” (46cm) long; use where not affected by temperature stratification or where ducts are smaller than 9sq ft. (1sq m).

5. Averaging Elements in Ducts: 36” (91cm) long, flexible 72” (183cm) long, flexible 18” (46 cm) long, rigid; use where prone to temperature stratification or where ducts are larger than 9sq ft (1sq m); length as required.

6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2” (64mm)

7. Outside Air Sensors: Outdoor aspirated air module for monitoring outside temperature and humidity. The enclosure shall be a NEMA 3R painted white to reduce radiation effects. The enclosure shall have a fan for power ventilation. Provide a 2% humidity transmitter and a 1000-ohm platinum 375 temperature transmitter. Watertight inlet fitting, shielded from direct sunlight.
8. Space sensors:
   a. Set-Point Adjustment: Concealed
   b. Set-Point Indication: Concealed
   c. Thermometer: Concealed
   e. Orientation: Vertical.
   f. Space temperature sensors shall match space thermostats.
   g. Locking cover.
   h. Three-speed fan speed adjustment if temperature sensor used in conjunction with a three-speed fan system.
   i. Insulating Bases: For thermostats located on exterior walls.
   j. Thermostat Guards: Locking; heavy-duty, transparent plastic mounted on separate base.
   k. Adjusting Key: As required for calibration and cover screws.
   l. Aspirating Boxes: For flush-mounted aspirating thermostats.
   m. Security Sensors: Stainless-steel cover plate with insulated back and security screws.
   n. Occupancy override with an adjustable time period from 1/2 to 3 hours.

C. Room Humidity Sensors: Bulk polymer sensor element.
   1. Accuracy: 1% full range with linear output.
   2. With locking cover matching room thermostats, span of 0 to 100%RH.
   3. Output: 4 – 20mA.
   4. The sensor shall be a Kele model HW1K or pre-approved equal.
D. Duct and Outside Humidity Air Sensors: Bulk polymer sensor element
   1. Accuracy: 1% full range with linear output.
   2. With element guard and mounting plate, span of 0 to 100% RH.
   3. Output: 4 – 20mA.
   4. The sensor shall be a Kele model HD1K, Kele model HO1K, or pre-approved equal.

E. Carbon Dioxide Sensors: Silicon-based NDIR sensor.
   1. Accuracy: 2% of reading +/-30 ppm.
   2. Linearity: +/-1%.
   4. Duct sensors shall be Kele GMD20 or pre-approved equal.
   5. Outside air sensors shall be provided with an analog temperature reading and shall be Kele GMA20T or pre-approved equal.

F. Oxygen Sensor
   1. Output: 4-20 mA.
   2. Range: 0-25% volume.
   3. Resolution: +/-0.1%.
   4. Operating range: 5 to 120°F and 5 to 99% RH.
   5. Input voltage: 14-30 VDC.
   6. Provide a Sierra model 4101-03EL or pre-approved equal.

G. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   1. Accuracy: 1% of full scale with repeatability of 0.1%.
2. Output: 4 – 20mA.

3. Building Static-Pressure Range: 0-0.25” wg (0-62 Pa).

4. Duct Static-Pressure Range: 0-5" wg (0-1243 Pa).

5. Provide a Setra M264 or pre-approved equal.

H. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4-20mA.

1. Two-wire capacitance.

2. NEMA 4X enclosure.

3. Rated for 0 to 100%RH and -40° – 185°F.

4. Dual component housing with a moisture barrier completely isolating the electronic circuitry from the field wiring and calibration terminals.

5. Operates with a 10 – 55VDC power supply.


7. Accuracy shall be ± 0.075% of calibrated span.

8. Rosemount 3051 or pre-approved equal.

I. Industrial Grade Pressure Transmitters: Air, liquid, gas, or vapor pressure transmitters shall be a diced range transmitter designed for harsh environments and suitable for high shock and vibration applications. Transmitter shall be constructed of stainless steel body and wetted parts with a 4 – 20mA output signal with 0.25% accuracy FS (RSS), (includes non-linearity, hysteresis, and non-repeatability). The housing shall be a NEMA 4X weatherproof type. The supply voltage shall be 24 – 30VDC with capability of driving a minimum loop resistance of 550ohms. The response time shall be less than 60 msec, the stability shall be 0.5% FS/year. The vibration effect shall be less than +/- 0.1% URL (Upper Range Limit) per ‘g’ when tested between 15 and 2000Hz in any axis relative to pipe mounted process conditions. Transmitter shall be able to be calibrated with an adjustable zero and span. The operating temperature range shall be -40° – 260°F (-40° – 125°C). The wetted parts shall be 17-4PH Stainless Steel, minimum, and the enclosure shall be stainless steel. Process
connection shall be ½” NPT. Calibrated range shall be selected to satisfy normal and extreme operating conditions.

Choose one of the following types of flowmeters

J. Flow Meters:

1. Turbine Meter (Insertion Type)
   a. Provide insertion type, turbine flow meters designed to mount through a fully open, 1 inch full bore ball valve supplied by flow meter manufacturer. Meter flow range shall be 2 – 40 ft/sec for liquid service. Meter linearity shall be +/- 1% for a 10:1 range. Repeatability shall be 0.10%. Turbine head and stem shall be constructed of stainless steel, bearings shall be tungsten carbide, and housing and flange shall be carbon steel. Housing pressure rating shall be 350psi. A D.C. powered, two-wire transmitter shall be mounted on the flow meter. The flow transmitter output shall be a 4 – 20mA signal that is linear with flow. Transmitter input shall be from magnetic pickup. Transmitter accuracy shall be 0.25% of span.

   b. Provide an isolation valve kit for turbine flow meters, including isolation valve, bypass valve, nipple, etc., to allow service and removal under pressure and while system is operating.

   c. Turbine meter shall be Onicon F 1120, Onicon F 1220, or pre-approved equal.

2. Controlotron Single Channel Energy/Flowmeter
   a. The Energy/Flowmeter shall be a Controlotron Single Channel Clamp-on Transient Time Ultrasonic Energy Meter Model 1010EN.

   b. The furnished Energy/Flowmeter shall be of a ruggedized clamp-on design precluding the requirement of penetrating into the pipe. Also, the Energy/Flowmeter shall be digital microprocessor based utilizing the Transient Time flow measuring technique employing a multiple pulse type signal in conjunction with multiple frequency transmission and axial beam transducer technology. Wetted transducer or electrodes, or flow measuring techniques previously described will not be acceptable.
c. The Energy/Flowmeter shall provide automatic transducer spacing, automatic Reynold’s number and liquid sonic velocity variation compensation and live zero flow measurement. The Energy/Flowmeter shall have the ability to indicate flow rate, flow velocity, total flow, Energy rate, energy Total, Temperature in and out, signal strength, liquid sonic velocity, liquid aeration, and Reynold’s Number. The Energy/Flowmeter shall provide self and application diagnostics to isolate any fault conditions due to either equipment failure or abnormal process conditions.

d. The Energy/Flowmeter electronics shall be powered by 115VAC, 60HZ. Two isolated 4 – 20ma outputs proportional to flow or Energy shall be provided. In addition, the Energy/Flowmeter shall provide two 0 – 10 Volt outputs assignable to T1, T2 or any other system parameters, an RS-232 Digital output and separate test port for diagnostic and calibration functions. An optional digital interface shall be available providing Modbus, N2 and Ethernet communications. The system shall be capable of interface to all common BMS systems.

e. Temperature measurement shall be via 4 wire direct connected 1000ohm platinum RTD’s. The RTD’s shall be matched to .04F. The temperature sensors may be insert or surface mount. Where surface mount sensors are used they must be insulated with a minimum of 2” of insulation for accurate performance.*** sensors utilizing temperature transmitters or sensors other than RTD’s shall not be permitted

f. The Energy/Flowmeter shall have an intrinsic accuracy of +/- 1 to 2% of flow over a range of +/- 40fps. Repeatability shall be 0.1% of flow sensitivity of 0.001fps at any flow rate including a zero flow condition. Time measurement resolution shall be in picoseconds to assure proper measurements at low flows. Nanosecond resolution will not be acceptable.

g. The Energy/Flowmeter shall also possess the following capabilities:

1) Auto-zero for zeroing flow without turning off flow

2) Auto-auto zero for repeated zeroing on a preprogrammed basis during operation

3) Cavitation and aeration detection.

4) Internal pipe wall build-up detection.
5) Liquid interface detection.

6) Simultaneous measurement of one (1) Energy and one (1) Flow Measurement.

7) Mode for non-homogenous liquids with high reflective solids content or extreme aeration.

8) Security password protection for individual sites.

9) Pipe simulator for system integrity and calibration check-out.

10) Reverse flow and empty pipe detection.

h. The System components shall be:

1) (1) 1010EN Single Channel Energy/Flow Computer

2) (1) 1011HNS High Precision Transducers

3) (1) 1012FNH Mounting Frames

4) (1) 1012BN Spacer Bar

5) (1) 1012CN-50 Transducer Cable

6) (1) 991TW-1 Thermal RTD’s with Thermowells (Set) or 991TW insert sensors

7) (2) 992ECN-50 Temperature Cable

8) (1) 1012NFM Energy Manual

9) (1) Start-Up by the Manufacturer or his representative

i. The system shall be manufactured by Controlotron Corp. Hauppauge New York and distributed by PEMCO 1 (800) 417-3626.

3. Controlotron Dual Channel Energy/Flowmeter

a. The Energy/Flowmeter shall be a Controlotron Dual Channel Clamp-on- Transit Time Ultrasonic Energy Meter Model 1010EN.
b. The furnished Energy/Flowmeter shall be of a ruggedized clamp-on design precluding the requirement of penetrating into the pipe. Also, the Energy/Flowmeter shall be digital microprocessor based utilizing using the Transit-Time flow measuring technique employing a multiple pulse type signal in conjunction with multiple frequency transmission and axial beam transducer technology. Wetted transducer or electrodes, or flow measuring techniques previously described will not be acceptable.

c. The Energy/Flowmeter shall provide automatic transducer spacing, automatic Reynold’s number and liquid sonic velocity variation compensation and live zero flow measurement. The Energy/Flowmeter shall have the ability to indicate flow rate, flow velocity, total flow, Energy rate, energy Total, Temperature in and out, signal strength, liquid sonic velocity, liquid aeration, and Reynold’s Number. The Energy/Flowmeter shall provide self and application diagnostics to isolate any fault conditions due to either equipment failure or abnormal process conditions.

d. The Energy/Flowmeter electronics shall be powered by 115VAC, 60HZ. Four isolated 4 – 20ma outputs proportional to flow or Energy shall be provided. In addition, the Energy/Flowmeter shall provide four 0 – 10 Volt outputs assignable to T1, T2 or any other system parameters, an RS-232 Digital output and separate test port for diagnostic and calibration functions. An optional digital interface shall be available providing Modbus, N2 and Ethernet communications. The system shall be capable of interface to all common BMS systems.

e. Temperature measurement shall be via 4 wire direct connected 1000ohm platinum RTD’s. The RTD’s shall be matched to .04F. The temperature sensors may be insert or surface mount. Where surface mount sensors are used they must be insulated with a minimum of 2” of insulation for accurate performance** sensors utilizing temperature transmitters or sensors other than RTD’s shall not be permitted

f. The Energy/Flowmeter shall have an intrinsic accuracy of +/- 1 to 2% of flow over a range of +/- 40fps. Repeatability shall be 0.1% of flow sensitivity of 0.001fps at any flow rate including a zero flow condition. Time measurement resolution shall be in picoseconds to assure proper measurements at low flows. Nanosecond resolution will not be acceptable.

g. The Energy/Flowmeter shall also possess the following capabilities:
1) Auto-zero for zeroing flow without turning off flow

2) Auto-auto zero for repeated zeroing on a preprogrammed basis during operation

3) Cavitation and aeration detection.

4) Internal pipe wall build-up detection.

5) Liquid interface detection.

6) Simultaneous measurement of two (2) Energy and two (2) Flow Measurements.

7) Mode for non-homogenous liquids with high reflective solids content or extreme aeration.

8) Security password protection for individual sites.

9) Pipe simulator for system integrity and calibration check-out.

10) Reverse flow and empty pipe detection.

h. The System components shall be:

1) (2) 1010EN Single Channel Energy/Flow Computer

2) (2) 1011HNS High Precision Transducers

3) (2) 1012FNH Mounting Frames

4) (2) 1012BN Spacer Bar

5) (2) 1012CN-50 Transducer Cable

6) (2) 991TW-1 Thermal RTD’s with Thermowells (Set) or 991TW insert sensors

7) (4) 992ECN-50 Temperature Cable

8) (1) 1012NFM Energy Manual
9) (1) Start-Up by the Manufacturer or his representative

i. The system shall be manufactured by Controlotron Corp. Hauppauge New York and distributed by PEMCO 1 (800) 417-3626.

4. Single Channel Energy/Flowmeter

a. The Energy/Flowmeter shall be a Single Channel, Clamp-on Transit Time Ultrasonic Energy Meter

b. The furnished Energy/Flowmeter shall be of a clamp-on design precluding the requirement of penetrating into the pipe. Also, the Energy/Flow meter shall be digital microprocessor based utilizing using the Transit-Time flow measuring technique. Wetted transducer or electrodes, or flow measuring techniques previously described will not be acceptable.

c. The Energy/Flowmeter shall provide automatic transducer spacing, automatic Reynold’s number and liquid sonic velocity variation compensation and live zero flow measurement. The Energy/Flowmeter shall have the ability to indicate flow rate, flow velocity, total flow, energy rate, energy Total, Temperature in and out, signal strength, liquid sonic velocity, and Reynold’s Number. The Energy/Flowmeter shall provide self and application diagnostics to isolate any fault conditions due to either equipment failure or abnormal process conditions.

d. The Energy/Flowmeter electronics shall be powered by 115VAC, 60HZ. Two isolated 4 - 20ma outputs proportional to flow or Energy shall be provided. In addition, an RS-232 Digital output and separate test port for diagnostic and calibration functions. An optional digital interface shall be available providing Modbus, and Ethernet communications. The system shall be capable of interface to all common BMS systems.

e. Temperature measurement shall be via RTD’s. The temperature sensors may be insert or surface mount. Where surface mount sensors are used they must be insulated with a minimum of 2” of insulation for accurate performance sensors utilizing temperature transmitters or sensors other than RTD’s shall not be permitted

f. The Energy/Flowmeter shall have an intrinsic accuracy of +/- 1 to 2% of flow over a range of +/- 40fps. Repeatability shall be 0.1% of flow sensitivity of 0.001fps at any flow rate including a zero flow condition.
g. The Energy/Flowmeter shall also possess the following capabilities:
   1) Simultaneous measurement of one (1) Energy and one (1) Flow Measurement.
   2) Security password protection for sites.
   3) Reverse flow and empty pipe detection.

h. The System components shall be:
   1) (1) Single Channel Energy/Flow Computer
   2) (1) Pair of Transducers
   3) (1) Mounting Frames and related hardware
   4) (1) Spacer Bar
   5) (1) Transducer Cable
   6) (1) Thermal RTD's (Set)
   7) (2) Temperature Cable

i. The energy/flowmeter shall be manufactured by Controlotron, General Electric, or pre-approved equal.

5. Controlotron Single Channel Flowmeter
   a. The Flowmeter shall be a Controlotron Single Channel Clamp-on Transit Time Ultrasonic Flow Meter Model 1010N.
   b. The furnished Flowmeter shall be of a ruggedized clamp-on design precluding the requirement of penetrating into the pipe. Also, the Flow meter shall be digital microprocessor based utilizing using the Transit Time flow measuring technique employing a multiple pulse type signal in conjunction with multiple frequency transmission and axial beam transducer technology. Wetted transducer or
electrodes, or flow measuring techniques previously described will not be acceptable.

c. The Flowmeter shall provide automatic transducer spacing, automatic Reynold’s number and liquid sonic velocity variation compensation and live zero flow measurement. The Flowmeter shall have the ability to indicate flow rate, flow velocity, total flow, signal strength, liquid sonic velocity, liquid aeration, and Reynold’s Number. The Flowmeter shall provide self and application diagnostics to isolate any fault conditions due to either equipment failure or abnormal process conditions.

d. The Flowmeter electronics shall be powered by 115VAC, 60HZ. Two isolated 4-20ma outputs proportional to flow shall be provided. In addition, an RS-232 Digital output and separate test port for diagnostic and calibration functions. An optional digital interface shall be available providing Modbus, N2 and Ethernet communications. The system shall be capable of interface to all common BMS systems.

e. The Flowmeter shall have an intrinsic accuracy of +/- 1 to 2% of flow over a range of +/- 40fps. Repeatability shall be 0.1% of flow sensitivity of 0.001fps at any flow rate including a zero flow condition. Time measurement resolution shall be in picoseconds to assure proper measurements at low flows. Nanosecond resolution will not be acceptable.

f. The Flowmeter shall also possess the following capabilities:

1) Auto-zero for zeroing flow without turning off flow.

2) Auto-auto zero for repeated zeroing on a preprogrammed basis during operation.

3) Cavitation and aeration detection.

4) Internal pipe wall build-up detection.

5) Liquid interface detection.

6) Mode for non-homogenous liquids with high reflective solids content or extreme aeration.
7) Security password protection for individual sites.

8) Pipe simulator for system integrity and calibration check-out.

9) Reverse flow and empty pipe detection.

g. The System components shall be:

1) (1) 1010N Single Channel Flow Computer

2) (1) 1011HNS High Precision Transducers

3) (1) 1012FNH Mounting Frames

4) (1) 1012BN Spacer Bar

5) (1) 1012CN-50 Transducer Cable

6) (1) Start-Up by the Manufacturer or his representative

h. The system shall be manufactured by Controlotron Corp. Hauppauge New York.

K. Damper Endswitches

1. Provide a heavy-duty switch with plug-in, oil tight, watertight, and NEMA 3 construction (unless exposed to outside air type conditions). Shall be rated to operate from -40° – 212°F (-40° – 100°C). Shall have a side rotary switch for use with interchangeable levers. Shall have LED position and operation indicators. Shall be Omron, D4A series or pre-approved equal.

L. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 – 5” wg (0 – 1243 Pa).


3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175% of rated motor current.
M. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2-to 10-V dc, feedback signal.

N. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vapor proof type.

O. Water Differential Pressure Switches: Chilled water and condenser water application. Hermetically sealed SPDT contacts; stainless steel bourdon tube (or bellows) sensing element; fixed deadband; setpoint shall be at about midpoint of operating range; electrical rating of 5A at 120VAC; manual adjustable setpoint; vibration resistant; weatherproof enclosure; snap-acting switch type.

P. Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die-cast aluminum housing, adjustable setpoint, and minimum 5A switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. Switch shall be automatic reset type.

Q. Water Level Sensors: Furnish and install full height, analog level sensor/transmitters. Transmitter shall provide 4 – 20mA signal in proportion to water level. Provide NEMA4 waterproof enclosure and mounting hardware as required. Provide an alarm unit with at least two adjustable level alarm contacts and a horn. The sensor shall be Drexel Brook or equal.

R. Garage Carbon Monoxide Detection System

1. The gas monitoring system shall be a central monitoring station connected to up to (4) remote gas sensors/transmitters. The central station shall be housed in a rugged, NEMA 4X enclosure. The central station shall have a large four-digit LED display that sequentially shows the gas concentration as well as the active channel number. The central station shall contain (4) warning relays, one for each sensor, that can be interfaced to third-party equipment. An alarm horn and fault relay shall be included in the central station. The central station shall be password protected. The warning, alarm setpoints, and full scale range of the sensor shall be set via the keypad.

2. Sensors shall be 4 – 20mA type sensors.

3. A DC battery connection shall allow battery backup operation.

4. System shall be a MSA Quad Gas II Gas Monitoring System or pre-approved equal.
S. Refrigerant Monitoring System

1. Dual-level detectors, using solid-state sensors, with alarm preset for 300ppm, alarm indicator light, alarm silence light and button, alarm test light and button, and trouble light. Provide auxiliary relay preset for 150ppm.

2. The refrigerant monitoring system shall be installed and wired by the BMS contractor.

3. Install a long-term, refrigerant leak detection system to detect A1 and B1 refrigerant leaks. The leak detection system shall transmit alarms to the BMS via dry contacts. Each refrigeration machine shall be monitored by at least two sensors (additional sensors to be provided if recommended by the manufacturer’s specifications), located on either side of the machine and 18” above the floor or at suggested manufacturer location. The system shall utilize a multi-channel scanner to monitor each sensor location and provide a method for setting the zero reference point. The following alarm relay outputs shall be monitored by the BMS:
   a. TLV, start purge ventilation
   b. STEL, three times TLV
   c. EEL
   d. Failure relay.

4. The system shall be provided with a remote reset switch, located outside the plant. The alarm shall be reset only after the refrigerant is cleared.

5. Provide an alarm horn, strobe light, and silence switch at each entrance to the plant, above the break glass switch. Alarm to activate when leak occurs. Horn shall be able to be silenced from switch and strobe shall continue to operate until condition is cleared.

6. Provide emergency power to system.

7. System shall be MSA "Chillgard IR" or equal.

8. The BMS Contractor shall coordinate with the HVAC Contractor and the successful refrigeration machine manufacturer to determine the location of refrigerant sensors and panels.
9. The BMS Contractor shall coordinate the type of refrigerant sensed with the type of refrigerant utilized by the associated chiller.

T. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180° field of view with vertical sensing adjustment, for flush mounting.

2.24 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-, three-, or four-position, push-button or lever-operated fan switch.

1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," and "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on two-gang switch box.

B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.

1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.

2. Dead Band: Maximum 2°F.

D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.

2. Bulbs in air ducts with flanges and shields.

3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.

4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.

5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.
6. **Modulating Thermostats:** Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

E. **Fire-Protection Thermostats:** UL listed with fixed or adjustable settings to operate at not less than 75°F above normal maximum operating temperature, with the following:

1. **Reset:** Automatic with control circuit arranged to require manual reset at central control panel, with pilot light and reset switch on panel labeled to indicate operation.

F. **Room Thermostat Cover Construction:** Manufacturer’s standard locking covers.

Subparagraphs below are optional.

1. **Set-Point Adjustment:** Concealed.
2. **Set-Point Indication:** Exposed.
3. **Thermometer:** Exposed
4. **Color:** Match space temperature sensors.
5. **Orientation:** Match space temperature sensors.

G. **Room thermostat accessories include the following:**

1. **Insulating Bases:** For thermostats located on exterior walls.
2. **Thermostat Guards,** transparent plastic; mounted on separate base. **Adjusting Key:** As required for calibration and cover screws.
3. **Aspirating Boxes:** For flush-mounted aspirating thermostats.

H. **Immersion Thermostat:** Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

I. **Electric Low-Limit Duct Thermostat:** Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point. **Setpoint** shall be adjustable. **Switch** shall be automatic reset type.

1. **Bulb Length:** Minimum 20ft.
2. Quantity: One thermostat for every 20 sq ft of coil surface.

J. Electric High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.


   2. Quantity: One thermostat for every 20 sq ft of coil surface.

K. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

L. Programmable Thermostat with Modulating Heating and 2 Stages of Cooling (or Vice Versa):

   1. The programmable thermostat shall be low voltage, microprocessor-based, and shall have an integral keypad and display for programming and scheduling. The scheduling feature shall include a 7-day time clock with two setback intervals per day.

   2. The programmable thermostat shall have a limited temporary setpoint adjustment, definable in programming, and a local override button with remote override capability. The status of all inputs and outputs shall be monitored locally through the use of the keypad and display. Thermostats shall support outdoor air temperature heating and cooling lockouts, discharge air temperature high and low limits, fan status, and filter status. Thermostats shall include one modulating output for heating or cooling and one two-stage output for heating or cooling. An adjustable delay on power up shall be available for soft start of systems upon restoration of power after a power loss.

   3. Thermostats shall support a setpoint shift feature in which a digital input is used to shift the heating setpoint down and the cooling setpoint up by an adjustable amount. All system and fan switching shall be done through the microprocessor and must allow for disabling. The ability to edit operating control parameters shall be password protected via a user-definable security access code. The thermostat housing shall be off-white or white determined based upon the color of the other thermostats provided under this section. Thermostat shall be mounted 60” above the finished floor unless required to be 48” by the ADA. The keypad, unoccupied override, and RS485 communications jacks shall be accessible without removing the housing. Thermostats must support non-volatile memory such that upon a power loss, all programmed operating parameters shall be unaffected without the use of battery backup. All control functions shall continue to operate in the event of a communication failure.
4. Thermostats shall support both remote and local communications in accordance with EIA RS485 standards. All firmware communication protocols and command codes shall be published, open, and non-proprietary. Programmable thermostat shall be Model SZ1017a as manufactured by TCS/Basys Controls or a pre-approved equal.

2.25 HUMIDISTATS

A. Duct-Mounted Humidistats: Electric insertion, 2-position type with adjustable 2% throttling range, 20 to 80% operating range, single- or double-pole contacts.

2.26 RELAYS

A. Current Sensing Relay

1. Provide and install current sensors for all motor status points. Current sensor shall combine a status sensor for monitoring positive status, and a command relay for starting or stopping motors in a single package. Current sensor shall be split core, two-wire, loop powered, and sized for expected amperage. Unit shall be UL listed. Provide status LEDs for current sensed below setpoint, current sensed above setpoint, and loop power failure. The current sensor output shall be N.O., solid state, and rated for 0.1A at 30 VAC/DC. The relay output shall be N.O., and rated for 5A resistive, 3A inductive at 30VDC, 240VAC. Current sensor with command relay shall be a Hawkeye model H938 or pre-approved equal.

2.27 LEAK DETECTOR

A. Leak detector shall have mounting feet with legs adjustable up to 1-½”, gold-plated water detection probes, adjustable height, a green LED to indicate power, a red LED to indicate water detected, SPDT alarm contacts. The enclosure shall be cast aluminum, weatherproof with adjustable legs. The lead detector shall operate between 11 and 27 VAC/DC.

2.28 AIRFLOW MEASURING STATION

A. Station

1. Airflow measuring stations required to accomplish the specified control sequence shall be furnished under this section but installed under the sheet metal section.

2. Each airflow measuring station shall measure airflow by means of a network of static and total pressure sensors factory positioned and connected in parallel to produce an
averaged velocity pressure. The measured velocity pressure converted to airflow (CFM) shall have an accuracy of 2% of the full scale throughout the velocity range from 700 to 4,000FPM when measured under ideal laboratory conditions. The location of stations shall meet manufacturer's guidelines.

3. The maximum resistance to airflow shall not exceed 0.6 times the velocity head. The unit shall be suitable to withstand temperatures up to 250°F.

4. All interconnecting tubing between the air measuring and any remote metering or control shall be furnished and installed by the supplier of the station. A minimum of one static and one total pressure sensor shall be used for every 16 sq in of duct cross sectional area for ducts up to 4 sq ft in cross section. For larger ducts, a minimum of one static and one total pressure sensor shall be used for every 36 sq in of duct cross sectional area.

5. Interconnecting sensor manifolds shall equalize and relate each type of sensor measurement into one total pressure and one static pressure metering port. The permanent system pressure loss created by the unit shall not exceed .15 of the velocity head. Each airflow measuring station shall consist of 16-gauge sheet metal casing and an air straightening section with an open face area not less than 97%. The sheet metal contractor shall install airflow measuring stations.

6. Provide Air Monitor Fan-E or equal with an accuracy of ± 2%, a turndown of 6 to 1, and no pressure loss across the station.

7. Final locations to be coordinated with sheet-metal contractor and manufacturer to ensure installed actual accuracy meets specifications.

B. Velocity Pressure Sensor For Airflow Measuring Stations

1. Range: 0.1 – 0.5"wg (Size based on AFMS Output).

2. Accuracy: ± 0.25"wg

3. Transmitter: 4 – 20mA.

2.29 FAN INLET AIRFLOW TRAVERSE PROBE

A. Provide airflow traverse probes mounted in the fan inlet capable of continuously measuring the air volume of the respective fan.
B. The fan inlet airflow traverse probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probes and internally connected to their respective averaging manifolds. Sensor shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.

C. The fan inlet airflow traverse probes shall have symmetrical averaging signal takeoffs, and shall be of aluminum construction with hard anodized finish with galvanized steel mounting hardware.

D. The fan inlet airflow traverse probes shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.

E. The fan inlet traverse probes shall be the VOLU-probe/FI as manufactured by Air Monitor or pre-approved equal.

2.30 OUTSIDE AIR MONITOR

A. The monitor/controller shall be capable of direct measurement of airflow through an outside air inlet and produce dual outputs; one representing the measured airflow, and the other to control the inlet damper.

B. The monitor/controller shall contain an integral multi-line liquid crystal display for use during the configuration and calibration processes, and to display two measured processes (volume, velocity, temperature) during normal operation. All configuration, output scaling, calibration, and controller tuning will be performed digitally in the on-board microprocessor via input pushbuttons.

C. The monitor/controller shall measure inlet airflow with an accuracy of ±5% of reading over a range of 150-600 FPM or 250-1000 FPM and not have its reading affected by the presence of directional or gusting wind. Measured airflow shall be density corrected for ambient temperature variances, and atmospheric pressure due to site altitude.

D. The monitor/controller shall interface with existing building management systems, accepting inputs for fan system start, economizer mode operation, and an external controller setpoint, and provide flow deviation alarm outputs.
E. The sensors shall be constructed of materials that resist corrosion due to the presence of salt or chemicals in the air; all non-painted surfaces shall be constructed of stainless steel. The electronics enclosure shall be NEMA 1 NEMA 4; NEMA 4 with enclosure heater and insulation.

F. The monitor/controller shall be the VOLU-flo/OAM as manufactured by Air Monitor or pre-approved equal.

2.31 AUTOMATIC CONTROL VALVES

A. All automatic control valves shall meet the following requirements:

1. Fully proportioning.

2. Capable of operating at varying rates of speed to correspond to the exact dictates of the controllers and variable load requirements.

3. Maximum pressure drop: 3 psi.

4. Close against the maximum differential pressure of the system.

5. Body pressure rating and connection type construction shall conform to piping and fittings in which the valve is to be installed and to the valve schedules.

6. Cold water, hot water, and bypass valves shall have equal percentage flow characteristics. (characterize ball or globe type valves.)

7. Steam control valves to be single seated type with linear flow characteristics. The valve disc to be composition with bronze trim and steel for steam pressures above 15 psig. Whenever the steam flow rate requires a single valve larger than 2-1/2", provide two valves in parallel, operating sequentially.

8. Control valves 2” and smaller shall have cast iron or bronze bodies with screwed connections. Valves shall be Belimo, Warren, or pre-approved equal.

9. Control valves between 2-1/2” and 4” shall have cast iron or bronze bodies with flanged connections. Valves shall be Belimo, Warren 1800 Series, or pre-approved equal.

10. Control valves 4” and larger shall be Fisher "Vee-Ball", Tyco/KTM V-ball, Warren 1800 Series, or pre-approved equal.
2.32 AUTOMATIC CONTROL VALVES

A. Valves shall meet the following minimum requirements:

1. Be fully proportioning.
2. Be capable of operating at varying rates of speed to correspond to the exact dictates of the controllers and variable load requirements.
3. Be sized for a maximum pressure drop of 5 PSI.
4. Close against the maximum differential pressure of the system of 100 psi.
5. Have a body pressure rating and connection type construction that conforms to the piping in which the valve is to be installed as well as the fitting and valve schedules.
6. Bypass valves shall have equal percentage flow characteristics.
10. Bearing: PEEK.
11. Packing: PTFE.
12. Valve shall be Fisher Vee-Ball, Jamesbury, Dezurik, or pre-approved equal.

B. All valve actuation shall be electric. Pneumatic actuation is not acceptable.

C. Valve actuators shall meet the following minimum requirements:

1. Provide smooth modulation at design flow and pressure conditions.
2. Be sized to close against a differential pressure equal to the design pump head plus 15%.
3. Fail-safe in the last position in the event of power failure or signal failure.
4. Have electronic, proportional control and shall be direct-coupled.
5. Be equipped with a permanent declutchable manual override hand wheel and visual and electronic stroke indicators.

6. Operating Voltage: single phase 120 VAC.

7. Input Signal: 0-10 VDC, 4-20 mA.

8. Electronic Valve Position Indication: Visual scale indicating percent of travel and 2 to 10 VDC feedback signal.

9. Housing: Dry powder coated aluminum alloy.

10. Gear train: High alloy steel with high temperature lubricant.

11. Contain an internal heater.


13. Actuator shall be Bettis TorqPlus, Jamesbury, Dezurik, or pre-approved equal.

2.33 BUTTERFLY CONTROL VALVES

A. All butterfly control valves, where shown on the drawings or specified herein, shall be butterfly type with lug ends and shall be furnished with electric actuators.

B. The valve shall meet the following minimum requirements:


2. Valve disc: 316 stainless steel.


4. Valve seat: RTFE

5. Bubble-tight closure at 285psi or the required differential pressure across the disc

6. Maximum system operating temperature: minimum of 250°F.

7. Valves shall be full-bodied, full lug type only (Wafer type or semi-lugged valves will not be permitted).
8. Valves shall be bolted from both ends of the flanges.

9. Valve shall be manufactured by Tyco/Keystone, Vanessa, Jamesbury, Bray or pre-approved equal.

C. All valve actuators shall be electric type and shall meet the following minimum requirements:

1. Input: Modulating actuators require 4 – 20mA or 0 – 10VDC.

2. Gear housing material: Cast iron with double reduction type gear reduction consisting of worm and helical gearing.

3. Worm gear: Alloy bronze.


6. Seal materials shall be Viton.

7. Temperature rating shall be -20°C – 150°F.

8. Actuator shall be provided with a manually operated hand wheel for overriding the spring and actuator position.

9. Actuator shall include a speed control device (adjustable) to prevent the valve from too rapid a closure rate.

10. Actuator shall have an external position indicator.

11. Actuator motor shall meet the following minimum requirements:

   a. Singlephase, 115V type.

   b. Nominal duty of 15min.

   c. Dynamic torque nominal 20% of start torque.

   d. Class B standard insulation.

   e. Maximum current of 3A.
f. 120VAC heater.
g. Limit switch shall be gear driven.
h. Snap-acting switch with 16 contacts rated at 600V 6A resistive.
i. 60A inrush at 120VAC.

12. Actuator shall be manufactured by Limitorque, Tyco/Keystone, Bray or pre-approved equal.

D. All valve actuators shall be pneumatic and shall meet the following requirements:
   1. Hard anodized aluminum body
   2. Steel pinion shaft
   3. Full bearing support on all moving parts
   4. Seal materials shall be Viton.
   5. Temperature rating shall be -20° – 150°F.
   6. Actuator shall be provided with a manually operated hand wheel for overriding the actuator position.
   7. Actuator shall include a speed control device (adjustable) to prevent the valve from too rapid a closure rate.
   8. Actuator shall have an external position indicator.

2.34 BUTTERFLY CONTROL VALVES (ALTERNATE PRICE)
A. All butterfly control valves, where shown on the drawings or specified herein, shall be butterfly type with lug ends and shall be furnished with electric actuators.
B. The valve shall meet the following minimum requirements:
   1. Valve body: cast iron.
   2. Valve disc: Aluminum bronze
Valve shaft:  416 stainless steel.

4.  Valve seat:  Buna-N or EPDM.

5.  Bubble tight closure at 150psi or the required differential pressure across the disc

6.  Maximum system operating temperature: minimum of 212°F.

7.  Valves shall be full-bodied, full lug type only (Wafer type or semi-lugged valves will not be permitted).

8.  Valves shall be bolted from both ends of the flanges.

9.  Valve shall be manufactured by Jamesbury, Bray, Tyco/Keystone, or pre-approved equal.

C.  All valve actuators shall be electric type and shall meet the following minimum requirements:

1.  Input: 4-20mA or 0-10VDC.

2.  Gear housing material:  Cast iron with double reduction type gear reduction consisting of worm and helical gearing.

3.  Worm gear:  Aluminum bronze casting or cut alloy.

4.  Worm:  Chrome-moly steel or cut alloy.

5.  Temperature rating shall be -20° – 140°F.

2.35 DAMPERS

A.  Dampers:  AMCA-rated design; 0.1084” minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635” galvanized steel with maximum blade width of 8 inches.

B.  Blades shall be secured to 1/2” diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

C.  Operating Temperature Range:  From -40° – 200°F.
D. For standard applications, include optional closed-cell neoprene edging.

E. For low-leakage applications, use parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10CFM/sq ft of damper area, at differential pressure of 4” wg when damper is being held by torque of 50 in x lbf; when tested according to AMCA 500D.

F. Dampers used in a two-position application shall be parallel blade design. Dampers used in a modulating application shall be opposed blade design.

G. Choose either electric or pneumatic actuation below and delete other choice.

2.36 ACTUATION

A. All actuation shall be electric. Pneumatic actuation is not acceptable.

B. All valve and damper actuation shall be pneumatic except for terminal equipment valves and dampers, which shall be electric. Terminal equipment includes:

1. Cabinet Unit Heaters
2. Constant Air Volume (CAV) boxes
3. Duct-mounted reheat coils
4. Fancoil Units
5. Fan-Powered Variable Air Volume (VAV) Boxes
6. Radiation
7. Supplemental AC units
8. Unit Heaters
9. Variable Air Volume (VAV) boxes

C. Incremental Electronic Actuator for Terminal Equipment Valve and/or Damper Actuation
1. Incremental actuators shall be allowed for terminal equipment only.
2. Actuators shall be proportional, electronic, direct-coupled actuators used for modulating service. Actuators shall be equipped with metal housings and visual stroke indicators.

3. Actuators shall be equipped with a permanent manual adjustment.


5. Operating Voltage: 24VAC.

6. Input Signal: 3 wire floating, 0 – 10VDC, or 4 – 20mA.

7. Frequency: 50 – 60Hz.

8. Power Consumption: 1.5VA maximum.


10. Spring return position should be field adjustable with a switch.


12. Stroke: 7/32” (5.5mm) maximum.

13. For use when the maximum media temperature is 230°F.

D. Valve Actuation

1. Valve actuators shall:
   a. Be quiet in operation,
   b. Provide smooth modulation at design flow and pressure conditions.
   c. Be capable of operating in sequence with other valves and/or damper actuators when required by the sequence of operation.
   d. Be sized to close against a differential pressure equal to the design pump head plus 15%. Where pressure and flow combinations exceed ratings for commercial valves and actuators, industrial class valves and actuators shall be provided.
Valve actuators shall fail-safe in either the normally open or normally closed position in the event of power failure, signal failure or compressed air failure. Fail Safe positions are as follows:

1) Air-Handling Unit Preheat Valves Normally Open
2) Air-Handling Unit Cooling Valves Normally Closed
3) Air-Handling Unit Heating Valves Normally Open
4) Duct-mounted Reheat Coil Valves Normally Closed
5) All Humidification Valves Normally Closed
6) Radiation Valves Normally Open
7) Unit Heater Valves Normally Open
8) Cabinet Unit Heater Valves Normally Open

2. Electric Valve Actuation
   a. Actuator shall have electronic, proportional control and shall be direct-coupled with spring return.
   b. Actuators shall be equipped with a permanent manual override hand wheel and visual and electronic stroke indicators.
   c. Operating Voltage: 24VAC.
   d. Input Signal: 0-10VDC, 4 – 20mA.
   e. Power Consumption: 18VA maximum (valves 2” and under), 28VA maximum (valves 2-1/2” – 4”)
   f. Spring Return Time: 15 seconds maximum
   g. Spring return position should be field adjustable with a switch.
   h. Nominal Force: 225lb Minimum (valves 2” and under), 610lb. (valves 2-1/2”-4”)
i. Stroke: 3/4” (20mm) maximum (valves 2” and under), 1-1/2” (valves 2-1/2”-4”)

j. For use when the maximum media temperature is 300ºF.

3. Pneumatic Valve Actuation

a. All valve actuators shall be of the neoprene, rubber diaphragm piston type with easily replaceable diaphragm.

b. Actuator housing may be molded or die-cast zinc or aluminum.

c. All valve actuators operating in sequence with other instruments shall have positive pilot positioners incorporating positive mechanical feedback.

d. Actuator size and spring ranges selected shall be suitable for intended application.

e. Rate pneumatic actuators for a minimum 140kPa (20 psig).

f. Positive positioner to have the following performance characteristics:

1) Linearity: ±10% of output signal span.

2) Hysteresis: 3% of the span.

3) Response: 1/4 psig input change.

4) Maximum pilot signal pressure: 140kPa (20 psig).

5) Maximum control air supply pressure: 420kPa (60 psig).

g. Positive positioners shall be provided on all actuators to provide smooth modulation or proper sequencing.

h. Positive positioners shall be high capacity force balance relay type with suitable mounting provisions and position feedback linkage tailored for particular actuator.

i. Positive positioners shall use full control air pressure at any point in stem travel to initiate stem movement or to maintain stem position.
E. Damper Actuation

1. Damper actuators shall have external adjustable stops to limit the stroke in either direction.

2. All damper actuators shall have sufficient power to overcome friction of damper linkage and air pressure acting on louvers and to operate the damper smoothly throughout the entire damper range.

3. Actuators shall be sized with a torque greater than 150% of the design damper torque.

4. Actuators shall have mounting arrangement for location outside of the air stream. The damper actuators shall be mounted on the damper extension so that it is not burned in the wall construction.

5. Damper actuators shall fail-safe in either the normally open or normally closed position in the event of power failure, signal failure, or compressed air failure. Fail Safe Positions are as follows:
   a. Outside Air Dampers Normally Closed
   b. Return Air Dampers Normally Open
   c. Exhaust Air Dampers Normally Closed

6. Electric Damper Actuation for Modulating and Two Position Damper Actuation
   a. Provide proportional, electronic, direct-coupled spring return actuators for all automatic dampers used for modulating service. Each actuator shall be equipped with a brushless DC motor, self centering shaft coupling, metal housing, permanent manual override, visual stroke indicators, and built in adjustable start and span controls with the following specifications:
      1) Operating Voltage: 24VAC
      2) Input Signal: 0-10VDC, 4 – 20mA (modulating), on/off (two position)
      3) Frequency: 50 – 60Hz
      4) Power Consumption: 9VA Maximum
7) Minimum Torque: 144° lb

8) Angular Rotation: 90°

7. Pneumatic Damper Actuation

a. All damper actuators shall be of the neoprene, rubber diaphragm piston type with easily replaceable diaphragm.

b. Actuator housing may be molded or die-cast zinc or aluminum.

c. Actuators for vortex dampers, variable pitch-bladed dampers, or vane dampers shall be provided with positive positioners.

d. All damper actuators operating in sequence with other instruments shall have positive pilot positioners incorporating positive mechanical feedback.

e. Actuator size and spring ranges selected shall be suitable for intended application.

f. Rate pneumatic actuators for a minimum 140kPa (20psig).

g. Positive positioner to have the following performance characteristics:

1) Linearity: ±10% of output signal span.

2) Hysteresis: 3% of the span.

3) Response: 1/4psig input change.

4) Maximum pilot signal pressure: 140kPa (20psig).

5) Maximum control air supply pressure: 420kPa (60psig).

h. Positive positioners shall be provided on all actuators to provide smooth modulation or proper sequencing.
i. Positive positioners shall be high capacity force balance relay type with suitable mounting provisions and position feedback linkage tailored for particular actuator.

j. Positive positioners shall use full control air pressure at any point in stem travel to initiate stem movement or to maintain stem position.

2.37 VOICE DIALING NOTIFICATION SYSTEM

A. General

1. The Automatic dialer shall be a self-contained microprocessor controlled system capable of monitoring up to 4 alarm channels, temperature and AC power. The system shall be configured for operation by the user by means of the built-in keypad. The system shall allow limited access to programming remotely by touch-tone telephone. Upon detection of any alarm or status change, the system shall commence dialing telephone numbers and deliver a voice message identifying and describing the alarm condition(s). The alarm message shall be delivered in digitized human voice using messages recorded by the user. The system will continue to call telephone numbers in succession until a positive acknowledgment of the alarm message is received. Acknowledgment is accomplished by depressing tone keys from the called telephone, or by calling the system back within a programmed time period. The alarm may also be acknowledged using the local keypad. In addition, the system shall be able to receive incoming telephone calls. Upon answering, the system shall recite a status report and allow access to remote operation and programming. The system shall be FCC and DOC registered for direct connection to the telephone network. The system shall have a one year warranty from the manufacturer.

2. I/O Channel Attributes and Features

3. The system shall come standard with 4 dry contact input channels, configurable as NO or NC digital dry contact using 2mA loop current.

4. The system shall have the following built-in monitoring features:
   a. AC power failure detection.
   b. Temperature with pre-wired 2.8K thermistor (-60° – 175°F).
5. All monitored channels, including built-in monitoring features, shall allow local keypad programming of pertinent operational data including, but not limited to:
   
a. Input type (NO/NC).
   
b. High and Low limits (temperature).
   
c. Input recognition time (0secs – 272min).
   
d. Enable/disable for each channel to dial out for alarm.

6. The system shall have one built-in SPDT form C 5A 125VAC relay output. The output may be programmed to switch automatically or manually.

B. Communication Features

1. The system shall connect to a standard 2-wire telephone line using pulse or tone, with loop start only. The system shall recognize ringer frequencies from 16 to 60 Hz. No leased or dedicated lines shall be required. The system shall also be capable of being used on the same telephone line as other answering devices. Call progress detection shall ensure that the alarm dialout is not hindered by no answers or busy signals.

2. The system shall be capable of dialing up to 8 telephone numbers, 32 digits each. The system shall allow local keypad programming of the following telephone dialing information:
   
a. Dialing method (Pulse or tone).
   
b. Message repetitions (0 – 255).
   
c. Maximum number of calls (0 – 255).
   
d. Call delay time (0secs – 255secs).
   
e. Intercall delay time (0secs – 272mins).
   
f. Redial on busy (enable/disable).

3. The System shall have the ability to record, store and reproduce voice messages and to use those messages to articulate the location and status of the monitored channels. In absence of user-recorded voice messages, the system shall articulate channel status
using the internally resident vocabulary. All digitized speech message data shall be stored in nonvolatile memory with a 3V lithium battery backup. Such battery backup shall be capable of protecting speech memory for at least 2 years of complete power outage. There shall be one recorded identification message for the system, and one recorded alarm message for each input channel. Message length shall be 8 seconds per input channel and 10.5secs for the identification message.

4. The system shall be capable of intelligently dialing out to a numeric beeper or pager. The dialing sequence shall be programmable such that the pager number is dialed, the system waits for the telephone to be answered, and then additional identification DTMF digits are transmitted.

5. The system automatically seizes control of the phone line to make an alarm phone call when the alarm occurs. All other calls, including current calls, will disconnect and all extensions will be disabled. Extensions will remain cut off until the alarm is acknowledged.

C. Programming

1. The System shall contain an integral, sealed keypad for the purpose of locally programming all system data. Programming is assisted by synthesized voice guidance.

2. The system shall be remotely programmable using a standard touch-tone telephone. Remote programming shall be aided by menu-style voice guidance. The following parameters may be remotely programmed: (1) Alarm messages; (2) Identification message; (3) Turn output on/off; (4) Disable/enable inputs.

D. Remote Operation Features

1. The system shall allow the user to call into the unit at any time using any standard telephone to obtain a full status report of all monitored channels including present temperature and listen-in to on-site sounds. The status report shall be articulated using the resident voice-synthesized English vocabulary, in combination with digitized user-recorded voice messages.

2. An alarm on any monitored channel may be acknowledged remotely by pressing tones on a touchtone telephone keypad or by calling the system back within a specified time period. An alarm may also be acknowledged locally using the built-in keypad.

E. Enclosure and Environmental
1. The system shall be housed in a NEMA-4X fiberglass enclosure with a latched clear cover and shall be internally constructed to facilitate field upgrades, repair, and maintenance.

2. The system shall be provided with a UL listed 12VAC power transformer that the user may plug into a 117VAC outlet, +20%, 60Hz.

3. Each input shall have a corresponding LED that will indicate the alarm and acknowledgment status of each input.

4. The system shall have a built-in 12V 1.9AH sealed lead-acid rechargeable battery. This battery shall support approximately 12hrs of continued system operation in the absence of AC power.

5. Power and telephone connection shall have internal spike and surge protection using metal oxide varistors. The dry contact inputs shall be optically isolated.

F. The system shall be a Sensaphone Express or approved equal.

2.38 AIR COMPRESSOR

A. Provide a duplex type air compressor set complete with air tank, motors, V-belt drives, pressure switches, relief valve, pressure gauge, intake filter silencers, starters, electric alternator, and all other items and accessories. The two compressors shall be mounted on ASME National Board receiving tank. The entire unit shall be factory piped and wired. Compressor shall be sized as necessary to supply all pneumatics associated with the building automation system as well as the main air for all other HVAC equipment.

B. Each air compressor shall be suitable for 70 – 90psi working pressure and shall be capable of supplying compressed air at 80psi under maximum CFM and be capable of maintaining 15/20psi air pressure (nominal) in the entire system with the compressor in operation less than 1/3 of the time that is required, and at a speed of 450rpm. Each compressor shall be single stage, one or two cylinders, air cooled, with drop forged steel crankshaft supported on both ends by means of ball, roller or sleeve main bearings. Lubrication shall be of the constant level splash type, or of the pressure type, to assure adequate supply of oil to all working parts. Compressor shall be provided with oil proof piston rings.
C. The air compressors shall be connected to an ASME air storage vessel of sufficient size to prevent in excess of 6 starts/hr.

D. Each compressor motor shall be provided with a magnetic starter with disconnect, three overload relays, and pressure switch. Provide an electric alternator to alternate automatically the starting sequence of the compressor motors. Electric controls shall be factory installed on the unit. A complete wiring diagram shall be secured to the interior of the cabinet door.

E. Compressor unit shall be painted with a prime and finish coat of paint in accordance with the manufacturers standard practice. Air tank shall be provided with a drain opening at the bottom, which shall be piped near the floor with gate valve and discharge into a floor drain.

2.39 AIR DRYER SYSTEM

A. Provide in parallel (2) refrigerated air dryers for the compressed air system at each location, one piped as a standby. Each unit shall consist of a hermetically sealed, direct connected refrigerant compressor and motor unit, automatic drain valve, non-toxic refrigerant, automatic expansion valve, condenser, lubrication system insulation, and other items and accessories, contained in a wall mounted cabinet. The air dryers shall be connected in to the high-pressure side of the compressed air line with copper tubing between the air tank and the pressure reducing station. Each unit shall be non-cycling type, with sufficient capacity to chill the compressed air output of one compressor, to a dewpoint of 35°F with an inlet air temperature of 100°F air (based on 110°F ambient temperature) required for normal temperature control system operation. Air dryers shall be piped with manual bypass.

B. Provide a compressed air pressure reducing station complete with two (2) air filters, two (2) oil filters, reducing valves, safety valves, isolating valves, gauges, brass piping and fittings. The use of type K copper tubing with brass or copper solder joint fittings is also acceptable for assembling this station. The reducing station shall be wall mounted adjacent to the air compressor and in each MER. Equipment and piping shall be arranged to provide identical parallel paths for the compressed air to be discharged to the temperature control system at the reduced pressure required for the mode of operation.

C. Provide a replaceable media cartridge type particulate and oil filters in the air piping between the refrigerated dryer and the pressure reducing station. Filters shall be so designed that the media can be replaced without removing the entire unit from the piping. A drain, with valve or petcock, shall be provided at the bottom of the filter assembly. Provide, per air pressure reducing station, two (2) pre-filters and two (2) oil filters, each sized for the compressed air requirements. Filters shall provide a dirt and oil free system. Isolation and changeover valves shall permit uninterrupted service during maintenance.
D. Provide 2 pressure reducing valve parallel branches, each branch having a minimum of three, ½” pressure reducing valves. These valves shall reduce the air pressure, in stages, from 80psi to 30psi – 19psi – 15psi. (these pressures are nominal and may differ from manufacturer to manufacturer)

E. Provide high pressure (80psi) to each MER.

F. Provide an approved make ASME standard bronze safety valve at the air tank and after each pressure reducing valve. The safety valve at the air tank shall be 3/4”, set at 80psi and each safety valve after the primary reducing valve shall be ½”, set at 38psi. Safety valves after the other pressure reducing valves shall be ½”, set approximately 5psi higher then the setting of the reducing valve it follows. Safety valves shall be Crosby Valve & Gauge Co., Kunkle Valve Co. or J.E. Lonergan Co.

G. Provide compressed air system sized for system requirements plus 50% spare capacity.

2.40 AIR GAUGES

A. Provide air pressure gauges on all main compressed air systems including, main station, air filters, pressure reducing valves, etc. Gauges shall have a 2-1/2” diameter, minimum.

B. Provide air pressure gauges on controlled equipment compressed air signals. Gauges shall be 1-1/2” in diameter, minimum.

2.41 PRESSURE REDUCING STATIONS

A. Provide dual pressure reducing stations in each MER. Station shall incorporate air filters, gauges, manual valves and pressure reducing valves to provide low pressure air as required. Station shall be piped to provide 100% standby and be valved to allow maintenance without compressed air shut down.

2.42 CONTROL AIR PIPING

A. No air lines are to be hidden within duct insulation. All piping and tubing shall be properly supported using straps, cleats, or hangers as approved. Use of wire will not be permitted. Where this specification permits the use of plastic tubing (inside control panel), virgin polyethylene tubing, with a molecular weight of not less than 25,000 and a melt index of
not more than .3°F/min, shall be supplied. Pressure rating: 160psi/72°F. Ambient temperature rating: 100°-175°F. Tubing shall be supported with pipe rests or other supporting methods as to prevent the lines from stress conditions.

B. Tubing passing through or buried in concrete shall be hard drawn copper in rigid steel conduit.

C. Air tubing shall be hard drawn copper.

D. Air tubing in finished areas shall be run concealed.

E. Air tubing for low and high pressure mains shall be copper.

F. Polyethylene plastic tubing will be permitted in lieu of copper, except for high pressure mains or smoke control, in the following locations:
   1. Within control panels only.

2.43 TUBING

A. All tubing shall be copper, ASTM L, or black single tube polyethylene ASTM type 1, gauge 5, class C, self-extinguishing (FR) plastic.

B. Copper Tubing

1. Provide ASTM B75 or ASTM B88 rated tubing. Tubing having an outside diameter .375” and larger shall have a minimum wall thickness equal to ASTM B88, type M. Tubing having an outside diameter less than .375” shall have a minimum wall thickness of .025”. Concealed tubing shall be hard rack multiple tubing. Tubing for working pressures greater than 30 psi shall be hard copper. Racked and individual tubes shall be permanently identified at each end. Fittings shall be solder type ANSI 16.18 or ANSI/ASME B16.22, using ASTM B32, 95-5 tin-antimony solder, or compression type ASME/ANSI B16.26.

C. Identification of tubes: The individual tubes shall be consecutively numbered starting with the first system. As a number is assigned to a tube, that number will appear at the terminating points of that tube (e.g., if Tube 2 was the number given to a master outside air reset signal, wherever that tube entered a panel, etc., it would still be Tube 2). Provide for spare numbers at each local panel.

2.44 COMPRESSED AIR SUPPLY
A. Accessories: Accessories shall be automatic traps on compressed air storage tanks, air dryers piped to drain, high-efficiency pre-filters, after filters for 99% oil and 0.3micron solid particle removal, intake silencers, relief valves, pressure switches and gauges and refrigeration type air dryer to maintain 38°F dewpoint, drains, bypasses, shutoff valves and vibration isolators for compressors and piping. Vibration isolators shall be in accordance with Section Vibration Isolation.

2.45 DEFINITIONS

A. ATC: Automatic Temperature Control.
B. BMS: Building Management System.
C. CFM: Cubic Feet per Minute.
D. DDC: Direct-digital controls.
E. FAS: Fire Alarm System.
F. HVAC: Heating, Ventilating, and Air Conditioning.
G. LAN: Local area network.
H. LCD: Liquid Crystal Display
I. MER: Mechanical Equipment Room.
J. MS/TP: Master-slave/token-passing.
L. PID: Proportional Integral Derivative.
M. POT: Portable Operators Terminal.
N. RAHU: Rooftop Air Handling Unit.
O. VAV: Variable air volume.
P. VFD: Variable Frequency Drive.

2.46 SYSTEM DESCRIPTION
A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

Retain paragraph below and delete paragraph above for distributed control systems.
B. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and programmed to control mechanical systems.

C. Control system includes the following:
   1. Building intrusion detection system specified in Division 13 Section "Intrusion Detection."
   2. Building clock control system specified in Division 13 Section "Clock Control."
   3. Building lighting control system specified in Division 13 Section "Lighting Controls."
   4. Fire alarm system specified in Division 13 Section "Fire Alarm."

2.47 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
   3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

B. Engage a factory-authorized service representative to perform startup service.

C. Replace damaged or malfunctioning controls and equipment.

   1. Start, test, and adjust control systems.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.

3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

2.48 COMMISSIONING

A. Prior to full operation, the contractor in the presence of the owner’s representative and engineer shall perform a complete demonstration and testing of the system operating functions and alarms. This testing shall take place after having satisfactorily met the requirements of shop drawing acceptance. Upon successful completion of system operation, the contractor shall submit a statement in writing stating that the full operation of all systems, functions, and alarms has been demonstrated and are operational as well as a listing of all systems, alarms, and functions that have been commissioned. All items shall be submitted for review and acceptance to the owner, owner’s representative, and engineer before final acceptance can take place.

2.49 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 1 Section “Closeout Procedures” and “Demonstration and Training.”

2.50 TRAINING

A. The BMS contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation, and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30PM weekdays.

B. Provide 16hrs of training for Owner’s operating and maintenance personnel. All training shall be on-site training. Videotape all sessions and edit each session to 1-hour tapes. Turn over two copies each unedited and edited tape to the Owner. Training shall include:

1. Explanation of drawings, operator’s and maintenance manuals.

2. Walk-through of the job to locate all control components.
3. Operator workstation and peripherals.

4. DDC Controller and ASC operation/function.

5. Operator control functions including graphic generation, if design includes color graphics, and field panel programming.

6. Explanation of adjustment, calibration and replacement procedures.

C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer’s standard pricing such as transportation, meals, etc.

2.51 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project-site visits, when requested by Owner, to adjust and calibrate components and to assist Owner’s personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION 230900
SEQUENCE OF OPERATIONS
SECTION 230993 - SEQUENCE OF OPERATIONS

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the contract, including general and supplementary conditions and division 1 specification sections, apply to this section.

B. SUMMARY

1. This section includes control sequences for hvac systems, subsystems, and equipment.

C. Related Sections include the following:

1. Division 15 Section "HVAC Instrumentation and Controls" for control equipment and devices and submittal requirements.

D. Definitions

1. ATC: Automatic Temperature Control.
2. BMS: Building Management System.
3. CFM: Cubic Feet Per Minute.
4. DDC: Direct-digital controls.
5. FAS: Fire Alarm System.
6. HVAC: Heating, Ventilating, and Air Conditioning.
7. MER: Mechanical Equipment Room.
8. RAHU: Rooftop Air Handling Unit.
9. VAV: Variable air volume.
10. VFD: Variable Frequency Drive.

E. GENERAL
1. Any safety shutdown shall allow for an automatic local reset and a manual remote reset and restart from the BMS system. All safety devices shall be hardwired to the starter and shall have a second contact for monitoring via the BMS.

2. All setpoints including setpoints internal to control algorithms shall be adjustable from all BMS operator interfaces.

3. All alarm points shall be annunciated at the BMS audibly and visually.

4. All controllers shall incorporate proportional-integral-derivative control loops.

5. All points for a specific mechanical system shall be connected to and controlled by the same DDC controller unless otherwise specified. For example, it is not acceptable to control a supply fan with one DDC controller located at a motor control center and to control the rest of the air-handling unit points with a DDC controller located at the air-handling unit.

6. When there is a building wide emergency condition, including but not limited to, fire alarm, loss of power, switchover from normal power to emergency power, switchover from emergency power to normal power, etc., all BMS alarms (i.e., fan failure, pump failure, etc.) due to these conditions shall be inhibited. All alarms indicating the type of emergency condition or reason for the emergency condition shall remain active.

7. The BMS operating system and software shall be upgraded to the latest edition available on all operator workstations and operator interface devices.

8. Submit on wiring diagrams and control diagrams for all equipment listed herein regardless of whether the controls are packaged, provided by others, etc. It is the intent of this specification that this Contractor shall provide the Owner with complete and final O & M manuals that include controls for ALL equipment regardless of who provided it.

9. All points required by the sequence of operation including but not limited to the operator interface points listed in the sequences of operation below, as well as all of the points’ associated values, shall be available to the BMS operators on all operator workstations and all operator interface devices as part of a graphical display that graphically depicts the mechanical system controlled.

10. The installed BMS shall have dedicated, LAN based communication buses independent of the building IT network for both primary and secondary buses.
11. All valves, dampers, controllers, control devices, etc. exposed to outside air conditions shall be specifically designed for outside air conditions including, but not limited to, NEMA 4 enclosures, weatherproof enclosures, and all other weather precautions recommended by the manufacturer.

12. The BMS contractor shall furnish, install, and wire a UPS for every primary control panel and every operator workstation.

13. The BMS shall monitor a contact from the FAS for each smoke zone indicating that a fire condition exists in the zone. One (1) contact shall be monitored for the entire building, each floor, each portion of a floor, etc. that constitutes a smoke zone.

F. Heat tracing

1. The BMS shall monitor the following heat tracing points. Contractor shall provide all interlock wiring between the heat tracing and the BMS necessary.
   a. Common alarm.
   b. Failure alarm (indicated if outside air temperature is less 40 DegF (adj.) and the heat tracing status is off)
   c. Heat tracing on/off status (as sensed by a current sensing relay).

G. Automatic Restart Sequence

1. The BMS contractor shall submit an automatic restart sequence of operation that prioritizes the loads to be restarted, in order of importance, when a changeover in power occurs, either from normal power to emergency power or from emergency power to normal power, and when there is more than one piece of mechanical equipment to start at the same time (e.g., at the beginning of a normally scheduled occupied cycle). The automatic restart sequence of operation shall also show the time delays between the startup of each piece of mechanical equipment.

2. Simultaneous starting of motors shall be prevented by a sequential start program in the DDC system. This program shall also provide sequential restart after power failure of motors that were running prior to power failure.

3. Software time delay relays shall be provided in the DDC system to allow fan motors to cool down before restarting. Motors shall have both a minimum interval time (between
consecutive starts) and a minimum off time (between start and stop). The time periods shall be based on motor HP per the following table.

H. Time periods are in minutes.

<table>
<thead>
<tr>
<th>Motor Horsepower</th>
<th>¼-10</th>
<th>10-20</th>
<th>20-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Interval Time</td>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>Minimum Off Time (adj.)</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

1. Automatic restart of fans after a safety shutdown trip shall be software prohibited through the de-energization of the remote start/stop contact. Fan restart shall be manually initiated by the operator either locally or remotely through a computer workstation after resolving the cause for shutdown.

2. Operator Workstation: Display the following data:
   a. Individual minimum interval time for each piece of mechanical equipment.
   b. Individual minimum off time for each piece of mechanical equipment.
   c. Individual motor horsepower.
   d. Individual restart delay for each piece of mechanical equipment.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - SEQUENCES OF OPERATION

The sequences of operations described in this section provide the foundation for project-by-project sequences of operations and are meant to be edited based on the specific requirements of each project at the campus.

3.1 GENERAL
   A. Any safety shutdown shall allow for a manual local reset and a manual remote reset and restart from the BMS system. All safety devices shall be hardwired to the starter and shall have a second contact for monitoring via the BMS.
   B. A failure alarm, as included in the point list, shall indicate the type of equipment that has failed (pump, fan, valve, etc.) including the specific designation of the piece of equipment (e.g., supply fan SF-1). It is not acceptable to generate a general failure alarm.
C. Alarming devices such as freezestats, pressure safeties, etc. shall be wired so the contacts open in the alarm condition. All alarm points shall be annunciated at the BMS audibly and visually. All alarm points associated with varying values shall be provided with adjustable limits.

D. All setpoints including setpoints internal to control algorithms shall be adjustable from all BMS operator interfaces. All commands shall be overrideable from all BMS operator interfaces. All control points shall be adjustable or overrideable from the same graphic page that displays the points.

E. All controllers shall incorporate proportional-integral-derivative control loops.

F. All points for a specific mechanical system shall be connected to and controlled by the same DDC controller unless otherwise specified. For example, it is not acceptable to control a supply fan with one DDC controller located at a motor control center and to control the rest of the air handling unit points with a DDC controller located at the air handling unit.

G. All points required by the sequence of operation including, but not limited to, the points listed in the sequences of operation below, as well as all of the points’ associated values, shall be connected to the BMS and available to the BMS operators on all operator workstations and all operator interface devices as part of a graphical display that depicts the mechanical system controlled.

H. All valves, dampers, controllers, control devices, etc. exposed to outside air conditions shall be specifically designed for outside air conditions including, but not limited to, NEMA 4 enclosures, weatherproof enclosures, and all other weather precautions recommended by the manufacturer.

I. A failure alarm, as included in the point list, shall indicate the type of equipment that has failed (pump, fan, valve, etc.) including the specific designation of the piece of equipment (e.g., supply fan SF-1). It is not acceptable to generate a general failure alarm.

J. The BMS shall utilize the building LAN as the primary network. Ethernet drops shall be provided by others as required. Coordinate exact locations of all Ethernet drops. The BMS contractor is responsible for all other wiring, devices, etc required to connect to the LAN. The BMS shall have dedicated communication buses independent of the building network for all secondary buses.

K. The BMS Server/Workstation contractor shall furnish, install and wire a UPS for every operator workstation, printer and server. The BMS contractor shall furnish, install and wire a UPS for every primary controller if specified on a job-by-job basis.

L. No part of the programming specified herein shall be programmed into operator priority.

M. All alarms associated with equipment that is disabled shall be inhibited.

N. All initial field settings applied shall be saved as the default or last values on a point by point basis. These values shall be downloaded to the controller such that they are the default value if the controller loses power. A printed copy shall also be provided to the owner as part of the O & M manuals.
Sequence of Operations

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O. When the motor controller is equipped with an HOA, the motors shall only be controlled by the BMS when the HOA switch is in the auto position.

P. Freezestats, pressure safeties, interlocked dampers, etc. shall be wired to shutdown motors when the HOA switch is in both the hand and auto positions. It shall not be possible to override these or any other safety devices or any fire alarm system control functions, except in the case of an engineered smoke control system in which case freeze protection safeties shall be overridden.

Q. Where fans and dampers are to be hardwire interlocked, provide hardwire interlocks between the motor terminal strip and dampers such that the damper shall be driven open then the motor is required to start. Motor start-up shall not occur until the damper end switch indicates the damper is in the full open position. Where fans and dampers are hardwire interlocked, the interlocks shall apply in both the “hand” and “auto” positions of the HOA switch at the motor controller.

R. The point lists are provided for convenience and are not intended to be all-inclusive. All points required to provide the Sequence of Operation shall be included as if listed.

S. Each filter shall be monitored via a differential pressure transmitter not a switch, and alarm at the BMS when the filter is dirty. The differential pressure transmitter shall be provided with a local readout.

T. The BMS contractor shall be responsible for furnishing, installing, and wiring of controls not furnished, installed, or wired by others that are required for the sequence of operations.

3.2 CENTRAL REFRIGERATION PLANT – CHILLERS AND COOLING TOWERS

A. General

1. The BMS contractor shall provide control panels for the refrigeration plant as specified.

2. Safeties

   a. If a refrigerant leak is detected, all chillers shall be disabled, an alarm horn and strobe shall be activated and the exhaust air dampers for the refrigerant exhaust fans shall open. When the exhaust dampers are open, the refrigerant exhaust fans shall be energized.

3. Break-Glass Switches:

   a. Two (2) dual action (i.e., break-glass, pull lever) break-glass switches shall be located outside each exit of the chiller plant. One switch shall start the exhaust fan and the other shall stop the chillers. The break-glass switches shall be hard wired into the chillers and exhaust fan starter circuits. Break-glass switches to start fans shall be wired in parallel. Switches to stop chillers shall be wired in series.
Break-glass switches and associated wiring and conduit shall be furnished and installed under this Section of the Specifications.

4. Cooling tower cell vibration switches shall stop the fan via hardwired interlock when vibration exceeds setpoint.

5. The electric basin heater shall be staged on as necessary to maintain the cooling tower cell basin water temperature.

6. BMS shall monitor the basin heater status. The BMS contractor shall furnish, install, and wire new current sensing relays if no other method of monitoring the basin heater status (i.e., dry contact from the equipment). An alarm shall annunciate at the BMS if the outside air temperature is below 35°F (adj.) and the basin heater status is off.

B. The BMS contractor shall:

1. Furnish, install, wire and commission one (1) new ultrasonic BTU/flow meter. There shall be one (1) meter installed on the common chilled water supply or return piping for the entire refrigeration plant. The BTU/flow meter shall be provided with two (2) analog outputs. One (1) output shall be used for BTU and one (1) output shall be used for flow. The BMS contractor shall have the BTU/flow meter manufacturer review the location of meter.

2. The BMS shall monitor runtime for each piece of equipment associated with the central refrigeration plant (i.e., chiller, pump and fan).

3. Chiller command, common alarm and status points shall be hardwired to the BMS.

4. Chiller Sequencing (Modify as necessary depending on the number of chillers)

5. The lead chiller shall be indexed on via a manual command. Upon a command to enable the lead chiller, the BMS shall open the lead chiller isolation valves. When the valves are open, as sensed by valve end switches, the BMS shall energize the lead chilled water pump, condenser water pump and cooling tower. When the pumps are on, as determined by current sensing relays, and the condenser water supply temperature is suitable (greater than 60°F adj.) for the chiller, the BMS shall indicate an advisory message for the facility personnel to enable the lead chiller at the lead chiller packaged controls. The packaged chiller controls shall control to maintain a chilled water supply temperature of 47°F (adj.). The BMS shall have the
capability of adjusting the chilled water supply temperature setpoint via interlock to the packaged chiller control panel.

6. If the lead chiller is not able to maintain the chilled water load based on tonnage for a period greater than 15 minutes (adj.), the BMS shall indicate an advisory message for facility personnel to enable the second chiller. Facility personnel shall input into the BMS whether or not the second chiller shall be enabled. When the second chiller is enabled upon receiving a response from the operator, the BMS shall open the second chiller isolation valves. When the valves are open, as sensed by valve end switches, the BMS shall energize the second chilled water pump, condenser water pump and cooling tower. When the pumps are on, as determined by current sensing relays, the BMS shall indicate an advisory message for the facility personnel to enable the second chiller at the chiller packaged controls. The packaged chiller controls shall control to maintain a chilled water supply temperature of 47ºF (adj.). The BMS shall have the capability of resetting the chilled water supply temperature setpoint via hardwire interlock to the packaged chiller control panel.

7. If the lead and second chillers are not able to maintain the chilled water load based on tonnage for a period greater than 15 minutes (adj.), the BMS shall indicate an advisory message for facility personnel to enable the third chiller. Facility personnel shall input into the BMS whether or not the third chiller shall be enabled. Upon receiving a response for the operator, the BMS shall open the third chiller isolation valves. When the valves are open, as sensed by valve end switches, the BMS shall energize the third chilled water pump, condenser water pump and cooling tower. When the pumps are on, as determined by current sensing relays, the BMS shall indicate an advisory message for the facility personnel to enable the third chiller at the chiller packaged controls. The packaged chiller controls shall control to maintain a chilled water supply temperature of 47ºF (adj.). The BMS shall have the capability of resetting the chilled water supply temperature setpoint via hardwire interlock to the packaged chiller control panel.

8. If the lead, second and third chillers are not able to maintain the chilled water load based on tonnage for a period greater than 15 minutes (adj.), the BMS shall indicate an advisory message for facility personnel to enable the fourth chiller. Facility personnel shall input into the BMS whether or not the fourth chiller shall be enabled. Upon receiving a response for the operator, the BMS shall open the fourth chiller isolation valves. When the valves are open, as sensed by valve end switches, the BMS shall energize the fourth chilled water pump, condenser water pump and cooling tower. When the pumps are on, as determined by current sensing relays, the
BMS shall indicate an advisory message for the facility personnel to enable the fourth chiller at the chiller packaged controls. The packaged chiller controls shall control to maintain a chilled water supply temperature of 47ºF (adj.). The BMS shall have the capability of resetting the chilled water supply temperature setpoint via hardwire interlock to the packaged chiller control panel.

9. If the lead, second, third and fourth chillers are enabled and the chilled water load falls below the tonnage capabilities of the lead, second and third chillers, for a period of 30 minutes (adj.), the BMS shall indicate an advisory message for facility personnel to disable the fourth chiller. Facility personnel shall input into the BMS whether or not the fourth chiller shall be disabled. When the fourth chiller is disabled, the fourth chilled water and condenser water pumps shall be disabled. After a 30 second (adj.) delay, the BMS shall close the fourth chiller isolation valves.

10. If the lead, second and third chillers are enabled and the chilled water load falls below the tonnage capabilities of the lead and second chillers, for a period of 30 minutes (adj.), the BMS shall indicate an advisory message for facility personnel to disable the third chiller. Facility personnel shall input into the BMS whether or not the third chiller shall be disabled. When the third chiller is disabled, the third chilled water and condenser water pumps shall be disabled. After a 30 second (adj.) delay, the BMS shall close the third chiller isolation valves.

11. If the lead and second chillers are enabled and the chilled water load falls below the tonnage capabilities of the lead chillers, for a period of 30 minutes (adj.), the BMS shall indicate an advisory message for facility personnel to disable the second chiller. Facility personnel shall input into the BMS whether or not the second chiller shall be disabled. When the second chiller is disabled, the second chilled water and condenser water pumps shall be disabled. After a 30 second (adj.) delay, the BMS shall close the second chiller isolation valves.

12. The chillers shall be disabled if the condenser water temperature or chilled water temperature exceeds the manufacturer’s allowable temperature.

C. Chilled Water Differential Pressure Bypass Valve Control

1. Whenever any chilled water pump is energized, the bypass valve shall modulate as necessary to maintain the chilled water system differential pressure setpoint. If all chilled water pumps are de-energized, the bypass valve shall remain closed.
2. If the system differential pressure exceeds the high or low pressure limit, an alarm shall be annunciated at the BMS.

D. Cooling Tower Sequencing (Modify as necessary depending on the number of cooling towers and fans)

1. When a cooling tower is enabled, the cooling tower inlet and discharge isolation valves shall open. When condenser water flow is established, as determined by the condenser water pump status, the cooling tower algorithm shall be enabled.

2. If one (1) cooling tower cell is enabled, the following sequence of operation shall occur:

3. If the condenser water supply temperature rises above the condenser water supply temperature setpoint, the cooling tower fan shall be energized. The BMS shall modulate the cooling tower fan VFD as necessary to maintain the condenser water supply temperature setpoint.

4. If the lead cooling tower fan VFD is operating at minimum speed and the condenser water supply temperature falls below setpoint plus a differential, the cooling tower fan shall be de-energized.

5. If the cooling tower fan is de-energized and the condenser water temperature falls below setpoint plus a differential, the cooling tower winter bypass valve shall open and the cooling tower inlet isolation valve shall close. If the winter bypass valve is open, the inlet isolation valve is closed and the condenser water temperature rises above setpoint, the lead cooling tower inlet isolation valve shall open and the winter bypass valve shall close.

6. If multiple cooling towers are enabled, the following sequence of operation shall occur:

7. If the condenser water supply temperature rises above the condenser water supply temperature setpoint, the lead cooling tower fan shall be energized. The BMS shall modulate the lead cooling tower fan VFD as necessary to maintain the condenser water supply temperature setpoint.

8. If the lead cooling tower fan VFD is above 60% (adj.) and the condenser water supply temperature rises above the condenser water supply temperature setpoint, the second cooling tower fan shall be enabled. The BMS shall modulate the lead and second
cooling tower fan VFDs with matching speeds as necessary to maintain the condenser water supply temperature setpoint.

9. If the lead and second cooling tower fan VFDs are operating at minimum speed and the condenser water supply temperature falls below setpoint plus a differential, the second cooling tower fan shall be de-energized. The BMS shall modulate the lead cooling tower fan VFD as necessary to maintain the condenser water supply temperature setpoint.

10. Additional cooling tower cell fans shall be energized/de-energized in the same manner described above.

11. If the outside air wetbulb temperature falls below 40°F (adj.), all enabled cooling tower bypass valves shall open and inlet valves shall close.

12. The condenser water supply temperature setpoint shall equal to the outdoor air wet bulb temperature plus the design approach of the cooling tower. The condenser water supply temperature setpoint shall have a high limit of 95°F (adj.) and a low limit setpoint. Refer to the chiller manufacturer for actual allowable low limit temperature setpoint.

13. If a cooling tower cell is disabled, the inlet, discharge, and bypass valves shall close.

E. Free Cooling

1. If the outside air wetbulb temperature falls below the free cooling setpoint, the BMS shall indicate an advisory message suggesting that free cooling should be enabled. Facility personnel shall input into the BMS whether or not free cooling shall be enabled. When free cooling is enabled, as input into the BMS by facility personnel, all operating chillers shall be disabled and the free cooling heat exchanger primary and secondary isolation valves shall open. When the valves are in the proper position, as sensed by valve end switches, all chiller isolation valves shall be closed.

2. The lead and second chilled water pumps, lead and second condenser water pumps and cooling towers continue to operate during free cooling mode as specified above. The condenser water supply temperature shall be reset to 42°F (adj.).

3. As the outside air temperature rises and the condenser water set point of 42°F (adj.) cannot be maintained, the BMS shall indicate an advisory message suggesting that mechanical cooling be enabled. Facility personnel shall input into the BMS whether
or not mechanical cooling shall be enabled. When mechanical cooling is enabled, the BMS shall set the condenser water supply temperature setpoint to 85°F (adj.). The lead chilled water pump and lead condenser water pump shall continue to operate. The electric chiller isolation valves shall remain closed and the heat exchanger isolation valves shall remain open. The condenser water shall circulate through the condenser water temperature bypass loop and heat exchanger (i.e., the condenser water temperature bypass valves shall be positioned to allow the condenser water to 100% bypass the cooling towers) until the condenser water temperature reaches the minimum condenser water temperature setpoint for the electric chiller. When the condenser water temperature has reached the minimum condenser water temperature setpoint, the electric chiller isolation valves shall be opened. When the chiller isolation valves are open, as sensed by valve end switches, the heat exchanger isolation valves shall close and the chilled water system shall operate as specified above. The tower fans shall remain off while the condenser water is circulating.

4. Facility personnel shall have the ability to disable the advisory messages indicated above and to have the BMS automatically enable/disable free cooling per the above sequence. There shall be a user selectable point on the chilled water system graphic to allow the advisory messages to be turned on/off.

F. Make up Water Control

1. The make-up water pumps shall be started and stopped automatically through the BMS. The BMS shall start the lead make-up water pump when the cooling tower basin level is low as sensed by a float switch.

2. The BMS shall monitor pump status via current sensing relays. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS that notifies the BMS operator of the specific pump that has failed and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. The standby make-up water pump shall be energized in the event of a lead pump failure.

3. The lead make-up water pump shall be the pump with the lowest runtime hours. The standby make-up water pump shall be the pump with the highest runtime hours. The lead and standby pump shall be indexed on a weekly basis at a minimum. The priority of each pump shall be overrideable via the BMS.
G. Winter Operation

1. During sub freezefing weather, the fans shall be periodically cycled to avoid ice build up on fans.

2. Chiller Failure and Cycling
   a. Upon failure of a chiller, as sensed by a chiller failure (status does not equal command) or alarm point, a chiller failure alarm shall be generated on the BMS that notifies the BMS operator of the specific chiller that has failed and that chiller shall be commanded off. The BMS shall indicate an advisory message for the facility personnel to enable the next available chiller.

   b. The lead chiller shall be the chiller with the lowest runtime hours. The second chiller shall be the chiller with the second lowest runtime hours. The third chiller shall be the chiller with the third lowest runtime hours. The fourth chiller shall be the chiller with the highest runtime hours. The lead, second, third and fourth chiller shall be indexed on a weekly basis at a minimum. The priority of each chiller shall be overrideable via the BMS.

3. Pump Failure and Cycling
   a. The BMS shall monitor pump status via current sensing relays. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS that notifies the BMS operator of the specific pump that has failed and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. The BMS shall enable the next available pump.

   b. The lead pump shall be the pump with the lowest runtime hours. The second pump shall be the pump with the second lowest runtime hours. The third pump shall be the pump with the third lowest runtime hours. The fourth pump shall be the pump with the highest runtime hours. The lead, second, third and fourth pump shall be indexed on a weekly basis at a minimum. The priority of each pump shall be overrideable via the BMS.

4. Cooling Tower Failure and Cycling
a. The BMS shall monitor fan status via current sensing relays. At any time a cooling tower fan command does not equal a fan status, except immediately after startup, a cooling tower fan failure alarm shall be generated on the BMS that notifies the BMS operator of the specific fan that has failed and that fan shall be commanded off. The BMS shall wait 30 seconds to see the fan status change before indicating a fan failure alarm. The BMS shall enable the next available fan.

b. The lead cooling tower fan shall be the fan with the lowest runtime hours. The second cooling tower fan shall be the fan with the second lowest runtime hours. The third cooling tower fan shall be the fan with the third lowest runtime hours. The fourth cooling tower fan shall be the fan with the highest runtime hours. The lead, second, third and fourth cooling tower fan shall be indexed on a weekly basis at a minimum. The priority of each fan shall be overrideable via the BMS.

c. Provide the following points hardwired to each plant manager:

1) AI – Chilled water return temperature.
2) AI – Chilled water supply temperature.
3) AI – Chilled water system differential pressure.
4) AI – Chiller plant BTU (one (1) from BTU meter).
5) AI – Chiller plant flow (one (1) from BTU meter).
6) AI – Condenser water return temperature.
7) AI – Condenser water supply temperature.
8) AI – Free cooling heat exchanger chilled water return temperature.
9) AI – Free cooling heat exchanger chilled water supply temperature.
10) AI – Free cooling heat exchanger condenser water return temperature.
11) AI – Free cooling heat exchanger condenser water supply temperature.
12) AO – Chilled water differential pressure bypass valve control (0-100%).
13) AO – Chiller setpoint adjustment (one (1) for each chiller).
14) AO – Cooling tower fan VFD control (0-100%; one (1) for each valve).
15) DI – Chiller common alarm (one (1) for each chiller).
16) DI – Chiller status (one (1) for each chiller).
17) DI – Cooling tower fan status (via current sensing relay; one (1) for each cooling tower).
18) DI – Cooling tower fan VFD bypass status (one (1) for each tower fan).
19) DI – Cooling tower fan VFD common alarm (one (1) for each tower fan).
20) DI – Cooling tower vibration alarm (one (1) for each cooling tower).
21) DI – Isolation valve closed status (via end switch; one (1) for each valve).
22) DI – Isolation valve open status (via end switch; one (1) for each valve).
23) DI – Make-up water flow switch status.
24) DI – Pump status (via current sensing relay; one (1) for each pump).
25) DI – Refrigerant exhaust fan status (via current sensing relay).
26) DI – Refrigerant leak detected.
27) DO – Isolation valve command (open/close; one (1) for each valve).
28) DO – Pump command (one (1) for each pump).
29) DO – Refrigerant exhaust fan command.

d. Provide the following software points displayed on the BMS system graphic in addition to all hardwired points indicated above:

1) BTU meter failure (BTU meter reads zero).
2) Chilled water supply temperature setpoint.
3) Chilled water system command (enable/disable).
4) Chilled water system differential pressure setpoint.
5) Chiller failure.
6) City water make-up system failure.
7) Condenser water supply temperature setpoint.
8) Cooling tower fan failure.
9) Free cooling condenser water supply temperature setpoint.
10) Free cooling enable outside air wetbulb interlock temperature setpoint.
11) Free cooling mode command (enable/disable).
12) High and low chilled water supply temperature alarms.
13) High and low chilled water system differential pressure alarms.
14) High and low condenser water supply temperature alarms.
15) High and low free cooling heat exchanger chilled water return temperature alarms.
16) High and low free cooling heat exchanger chilled water supply temperature alarms.
17) High and low free cooling heat exchanger condenser water return temperature alarms.
18) High and low free cooling heat exchanger condenser water supply temperature alarms.
19) Individual chiller priority (lead, second, third, standby).
20) Individual chiller tonnage capability (manually input for each machine).

5. Individual cooling tower priority (lead, second, third, fourth).


8. Individual pump priority (lead, second, third, standby).


10. Isolation valve failure.

11. Outside air humidity (global point).

12. Outside air temperature (global point).

13. Outside air wet bulb temperature (global point).


15. Refrigerant exhaust fan failure.


17. Total chilled water load (tonnage; calculated by the BMS).

3.3 STEAM TO HOT WATER HEAT EXCHANGER AND HOT WATER PUMPS

A. The following sequence includes lead/lag control of heat exchangers and hot water pumps. For projects where there is only one heat exchanger and/or one hot water pump, treat this as the lead unit and disregard the standby unit points and the lead/standby switchover control.

B. Steam valves shall fail close. Provide two (2) control valves to control the steam input for each heat exchanger (four in total). The control valves shall be sized for 1/3 and 2/3 capacity. Provide an individual control output to each control valve.

1. The heat exchanger control algorithm shall be enabled when the outside air temperature falls below 65°F (adj.) or via a manual command. Upon a command to enable the lead heat exchanger, the lead heat exchanger isolation valves shall open and the lead hot water pump shall be energized.

2. For a variable speed system:
a. The BMS shall modulate the lead hot water pump VFD as necessary to maintain the system differential pressure setpoint. The pump VFD control algorithm shall be enabled whenever the associated pump is enabled. Provide start contact and speed setpoint to each pump VFD. The VFD shall start at 0% and slowly ramp up to speed as required by the differential pressure sensor. Pressure sensors shall be located just prior to the last load on each circuit. The sensor(s) shall be wired to the same controller that modulates the speed of the VFD. The VFD shall modulate as necessary to maintain the system differential pressure setpoint.

b. If the VFD is controlling at the minimum allowed level and there is an increase in system differential pressure, the differential pressure bypass valve shall be modulated open as necessary to maintain the system differential pressure. The bypass valve shall only be modulated open when the VFD is controlling at its minimum level. The bypass valve shall be modulated closed before the signal to the VFD is increased above the minimum level.

3. For constant speed system, a differential pressure bypass valve will be required to maintain the system differential pressure setpoint (unless otherwise specified):

   a. The hot water system control panel shall modulate the differential pressure bypass valve as necessary to maintain the system differential pressure setpoint. The differential pressure bypass control algorithm shall be enabled whenever the hot water pump is enabled. The BMS equipment control contractor shall provide a new water differential pressure sensor across the hot water supply and return. The sensor shall be wired to the same controller that modulates the bypass valve.

4. When the lead hot water pump is on, the heat exchanger’s 1/3 and 2/3 steam valves shall be allowed to operate. The staged 1/3 and 2/3 heat exchanger steam control valves shall modulate as necessary to maintain the heat exchanger discharge temperature setpoint. The heat exchanger discharge temperature setpoint shall be reset by the outside air temperature. The discharge setpoint shall be reset linearly from 120°F (adj.) to 180°F (adj.) as the outside air temperature falls from 60°F (adj.) to 0°F (adj.). Discharge temperature setpoints shall be adjusted based on the heat exchanger design temperatures.

5. When the heat exchanger algorithm is disabled, the steam control valves shall close and the hot water pump shall be de-energized and the isolation valves shall close.

6. Pump Failure/Switchover
a. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. An automatic lead/standby program shall start the standby pump in the event of a lead pump failure.

7. Heat Exchanger Failure/Switchover (for lead/standby applications)
   a. A heat exchanger failure shall be determined if any of the following conditions exist:
   b. The heat exchanger discharge temperature rises above or falls below setpoint by 5°F (adj.) for a period of 15 minutes (adj.).
   c. There is a failure of the heat exchanger isolation valve(s).

8. Upon a heat exchanger failure, the lead heat exchanger shall be disabled and the lag heat exchanger shall be enabled. The lag heat exchanger isolation valves shall open and the lead heat exchanger isolation valves shall close.

9. The lead heat exchanger shall be the heat exchanger with the lower runtime hours. The lag heat exchanger shall be the heat exchanger with the higher runtime hours. The lead and lag heat exchangers shall be indexed on a weekly basis at a minimum (adj.).

10. When a heat exchanger is disabled, its associated steam control and isolation valves shall close.
   a. Provide the following points hardwired to the BMS (where applicable):
      1) AI – Bypass valve feedback (0-100%).
      2) AI – Heat exchanger discharge temperature (common)
      3) AI – Hot water return temperature (common).
      4) AI – Hot water supply temperature (common).
      5) AI – Hot water system differential pressure.
6) AO – Hot water pump VFD control (0-100%; one (1) for each pump).
7) AO – Bypass valve control (0-100%).
8) AO – 1/3 steam valve control (0-100%; one for each heat exchanger).
9) AO – 2/3 steam valve control (0-100%; one for each heat exchanger).
10) DI – Hot water pump status (via current sensing relay; one (1) for each pump).
11) DI – Isolation valve position (open/close via end switch; one (1) for each valve).
12) DO – Hot water pump VFD command (enable/disable; one (1) for each pump).
13) DO – Isolation valve command (open/close; one (1) for each valve).

b. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above (where applicable):

1) Bypass valve failure alarm.
2) Heat exchanger command (on/off).
3) Heat exchanger discharge temperature reset parameters.
4) Heat exchanger discharge temperature setpoint.
5) Heat exchanger enable/disable outside air interlock setpoint.
6) Heat exchanger failure alarm.
7) High and low heat exchanger discharge temperature alarms.
8) High and low hot water system differential pressure alarms.
9) Hot water system differential pressure setpoint.
10) Hot water pump failure.
11) Hot water pump priority (lead/standby).

12) Individual hot water pump VFD common alarm (for each pump).

13) Individual hot water pump VFD feedback (0-100%, for each pump).

14) Isolation valve failure (for each valve).

15) Outside air temperature (global point).

3.4 VARIABLE AIR VOLUME RECIRCULATING AIR HANDLING UNITS

A. Safeties

1. The supply and/or return smoke detector shall stop the supply and return/exhaust fans upon the presence of smoke through the FAS.

2. A high discharge air pressure switch located downstream of the supply fan and upstream of the closest damper shall stop the supply and return/exhaust fans when duct pressure exceeds design. The supply and return/exhaust fans shall remain off until the air pressure switch is manually reset.

3. A low suction air pressure switch located upstream of the return/exhaust fan and downstream of the closest damper shall stop the supply and return/exhaust fans when duct pressure decreases design.

4. A freezestat installed on the discharge of the cooling coil shall disable the unit upon sensing a temperature below 40°F (adj.). The steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 90°F (adj.).

5. Leak detectors located in the drain pans below the chilled water and humidifier coils shall sound an alarm at the BMS upon sensing water.

B. Warm-Up/Cool-Down

1. During the heating season, a warm-up program shall be invoked if the return air temperature is below 60°F (adj.) upon unit start up. The warm-up program shall reset the supply air temperature to 80°F (adj.) and shall open all downstream VAV boxes to the maximum CFM position. The supply air temperature shall be reset linearly and inversely from 80°F (adj.) to 70°F (adj.) as the return air temperature increases from 60°F (adj.) to 70°F (adj.). During the warm-up mode, the air handling unit shall operate on 100% return air. After warm-up (return air above 70°F (adj.)), the unit
shall be controlled as described in occupied mode. (verify with facility personnel whether or not this sequence is needed)

2. During the cooling season, a cool-down program shall be invoked if the return air temperature is above 80°F (adj.) upon unit start up. The cool-down program shall reset the supply air temperature to 55°F (adj.) and shall open all VAV boxes to the maximum CFM position. During the cool-down mode, the air handling unit shall operate on 100% return air. After cool-down (return air below 70°F (adj.)), the unit shall be controlled as described in occupied mode. (verify with facility personnel whether or not this sequence is needed)

C. Occupied Mode

1. The air handling unit shall be started based upon a start time optimization program, time of day schedule, or manual command and run continuously.

2. Upon a command to start, all associated isolation dampers located at the unit shall open. Isolation dampers shall be hardwire interlocked to the supply fan starter by the BMS contractor. The outside air, exhaust air, and return air dampers shall modulate to minimum position. Hardwired damper end switches on all two-position dampers shall energize the supply and return/exhaust fan starters when all associated dampers are in their fully open position.

3. Supply and return/exhaust fan variable frequency drives shall start unloaded and slowly ramp up to speed as required. In the occupied mode, the supply and return/exhaust fans run continuously. The supply fan variable frequency drive shall be controlled to maintain the supply static pressure setpoint, as sensed at a point 2/3 downstream of the supply fan. The return fan variable frequency drive shall be controlled to maintain the return CFM, as sensed by a return airflow measuring station. The return CFM setpoint shall be calculated by adding a fixed value (the value may be positive or negative and shall be adj.) to the supply CFM, as sensed by a supply airflow measuring station. The exhaust fan variable frequency drive shall be controlled to maintain the exhaust CFM, as sensed by an exhaust airflow measuring station. The exhaust CFM setpoint shall be calculated by adding a fixed value (the value may be positive or negative and shall be adj.) to the supply CFM, as sensed by a supply airflow measuring station.

4. Economizer mode shall be available whenever the outside air enthalpy is less than the air handling unit return air enthalpy. If economizer is available and there is a rise in
supply air temperature above the supply air temperature setpoint, the outside air dampers and exhaust air dampers shall be modulated open from minimum position to 100% open as necessary to maintain the supply air temperature setpoint. The return air dampers shall modulate closed proportionately as the outside air and exhaust air dampers modulate open. If the outside air damper is 100% open and there is a further rise in temperature above supply air temperature setpoint, the outside air damper shall remain 100% open and the chilled water valve shall modulate open as necessary to maintain the supply air temperature setpoint.

5. When economizer mode is not available, the chilled water valve and steam/hot water valve shall modulate in sequence as necessary to maintain the supply air temperature setpoint. The steam/hot water valve shall modulate as necessary to maintain a minimum preheat coil discharge air temperature setpoint of 45°F (adj.).

6. If the preheat coil is equipped with face and bypass dampers, the following sequence of operation shall apply. If the outside air temperature is above 45°F (adj.), the face and bypass dampers shall be positioned to allow full flow over the preheat coil and the steam/hot water valve shall modulate as necessary to maintain setpoint. If the outside air temperature is below 45°F (adj.), the steam/hot water valve shall be fully open and the face and bypass dampers shall modulate as necessary to maintain setpoint.

7. The humidifier control valve shall modulate as necessary to maintain the return air humidity setpoint. If the supply air humidity rises above the high limit setpoint (adj.), the humidifier valve shall modulate closed as necessary to maintain the high limit setpoint. The humidifier valve shall not fully close upon reaching the high limit setpoint. The humidifier shall normally be located between the preheat and cooling coils.

8. If the return air humidity rises above the dehumidification setpoint of 60% RH (adj.), the chilled water valve shall be overridden open as necessary to maintain the return air humidity setpoint of 50% (adj.).

9. The outside air, return air, and exhaust air dampers shall be overridden as necessary to maintain the mixed air low limit setpoint.

10. Where appropriate on a job-by-basis: The outside air and exhaust air dampers shall be overridden open as necessary to maintain each individual space carbon dioxide level at the space carbon dioxide setpoint. The space carbon dioxide level setpoint shall be equal to 700 ppm (adj.). The return air damper shall modulate closed.
proportionately as the outside air and exhaust air dampers modulate open. (program sequence but lock out if space carbon dioxide sensors do not exist at time of installation of the air handling unit)

11. The supply static pressure setpoint shall be reset based on VAV CFM. If no VAV box is providing greater than 95% (adj.) of maximum CFM, decrease the supply air static pressure until a VAV box is providing greater than 95% (adj.) of maximum CFM. If a VAV box is providing greater than 95% (adj.) of maximum CFM and not maintaining the space temperature setpoint, increase the static pressure setpoint until the space temperature setpoint is being maintained.

D. Unoccupied Mode

1. The supply and return/exhaust fans shall remain off and the variable frequency drives shall be set to 0%. The return air damper shall open and the outside air and exhaust air dampers shall close. All isolation dampers shall close. The chilled water valve shall close and the steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 45°F (adj.). The humidifier control valve shall remain closed.

2. If the return air temperature or any space temperature falls below 60°F (adj.), the unit shall run as per warm-up mode until the return air temperature or space temperature exceeds 64°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

3. If the return air temperature or any space temperature rises above 80°F (adj.), the unit shall run as per cool-down mode until the return air temperature or space temperature falls below 76°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

E. Provide the following points hardwired to the BMS:

1. Al – Exhaust air CFM.
3. Al – Mixed air temperature.
4. Al – Preheat coil discharge air temperature.
5. Al – Return air CFM.
6. AI – Return air humidity.
7. AI – Return air temperature.
8. AI – Return or Space carbon dioxide level.
9. AI – Supply air CFM.
10. AI – Supply air humidity.
11. AI – Supply air static pressure.
12. AI – Supply air temperature.
13. AO – Chilled water valve control (0-100%).
14. AO – Exhaust fan VFD speed control (0-100%).
15. AO – Hot water valve control (0-100%).
16. AO – Humidifier valve control (0-100%).
17. AO – Outside air, exhaust air and return air damper control (0-100%).
18. AO – Return fan VFD speed control (0-100%).
19. AO – Steam valve control (0-100%).
20. AO – Supply fan VFD speed control (0-100%).
22. DI – Exhaust fan status (via current sensing relay).
23. DI – Exhaust fan VFD bypass status.
24. DI – Exhaust fan VFD common alarm.
25. DI – Freezestat status.
26. DI – Leak detector status.
27. DI – Return fan low intake pressure switch status.
28. DI – Return fan status (via current sensing relay).
29. DI – Return fan VFD bypass status.
30. DI – Return fan VFD common alarm.
31. DI – Supply fan high discharge pressure switch status.
32. DI – Supply fan status (via current sensing relay).
33. DI – Supply fan VFD bypass status.
34. DI – Supply fan VFD common alarm.
35. DO – Exhaust fan VFD command (enable/disable).
36. DO – Return fan VFD command (enable/disable).
37. DO – Supply fan VFD command (enable/disable).

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AHU command (enable/disable).
2. AHU mode (warm-up, cool-down, economizer, normal, etc.)
3. Dehumidification mode (on/off).
4. Dehumidification setpoint.
5. Dirty filter alarm (indicated if filter differential pressure exceeds 1” (adj.)).
6. Economizer available.
7. Exhaust air CFM setpoint.
8. Exhaust fan failure.
9. Exhaust fan low intake pressure alarm.
10. Freezestat alarm.

11. High and low exhaust air CFM alarms.

12. High and low preheat coil discharge air temperature alarms.

13. High and low return air CFM alarms.

14. High and low return air humidity alarms.

15. High and low supply air static pressure alarms.

16. High and low supply air temperature alarms.

17. High space carbon dioxide level alarms.

18. High supply air humidity alarm.

19. Leak detected alarm (indicating which leak detector was activated).

20. Mixed air low limit setpoint.

21. Occupied/unoccupied preheat coil discharge air temperature setpoint.

22. Outside air enthalpy (calculated).

23. Outside air temperature (global point).

24. Outside air humidity (global point).

25. Return air CFM setpoint.

26. Return air enthalpy (calculated).

27. Return air humidity setpoint.


29. Return fan low intake pressure alarm.

30. Setback and setup temperature setpoints.
31. Space carbon dioxide level setpoint.
32. Supply air humidity high limit setpoint.
33. Supply air static pressure reset parameters.
34. Supply air static pressure setpoint.
35. Supply air temperature reset parameters.
36. Supply air temperature setpoint.
37. Supply fan failure.
38. Supply fan high discharge pressure alarm.

3.5 CONSTANT AIR VOLUME RECIRCULATING AIR HANDLING UNITS

A. Safeties

1. The supply and/or return smoke detector shall stop the supply and return/exhaust fans upon the presence of smoke through the FAS.

2. A high discharge air pressure switch located downstream of the supply fan and upstream of the closest damper shall stop the supply and return/exhaust fans when duct pressure exceeds design. The supply and return/exhaust fans shall remain off until the air pressure switch is manually reset.

3. A low suction air pressure switch located upstream of the return/exhaust fan and downstream of the closest damper shall stop the supply and return/exhaust fans when duct pressure decreases design.

4. A freezestat installed on the discharge of the cooling coil shall disable the unit upon sensing a temperature below 40°F (adj.). The steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 90°F (adj.).

5. Leak detectors located in the drain pans below the chilled water and humidifier coils shall sound an alarm at the BMS upon sensing water.

B. Warm-Up/Cool-Down
1. During the heating season, a warm-up program shall be invoked if the return air temperature is below 60°F (adj.) upon unit start up. The warm-up program shall reset the supply air temperature to 80°F (adj.) and shall open all downstream VAV boxes to the maximum CFM position. The supply air temperature shall be reset linearly and inversely from 80°F (adj.) to 70°F (adj.) as the return air temperature increases from 60°F (adj.) to 70°F (adj.). During the warm-up mode, the air handling unit shall operate on 100% return air. After warm-up (return air above 70°F (adj.)), the unit shall be controlled as described in occupied mode. (verify with facility personnel whether or not this sequence is needed)

2. During the cooling season, a cool-down program shall be invoked if the return air temperature is above 80°F (adj.) upon unit start up. The cool-down program shall reset the supply air temperature to 55°F (adj.) and shall open all VAV boxes to the maximum CFM position. During the cool-down mode, the air handling unit shall operate on 100% return air. After cool-down (return air below 70°F (adj.)), the unit shall be controlled as described in occupied mode. (verify with facility personnel whether or not this sequence is needed)

C. Occupied Mode

1. The air handling unit shall be started based upon a start time optimization program, time of day schedule, or manual command and run continuously.

2. Upon a command to start, all associated isolation dampers located at the unit shall open. Isolation dampers shall be hardwire interlocked to the supply fan starter by the BMS contractor. The outside air, exhaust air, and return air dampers shall modulate to minimum position. Hardwired damper end switches on all two-position dampers shall energize the supply and return/exhaust fan starters when all associated dampers are in their fully open position.

3. In the occupied mode, the supply and return/exhaust fans run continuously.

4. Economizer mode shall be available whenever the outside air temperature is less than the air handling unit return air temperature. If economizer is available and there is a rise in supply air temperature above the supply air temperature setpoint, the outside air dampers and exhaust air dampers shall be modulated open from minimum position to 100% open as necessary to maintain the supply air temperature setpoint. The return air dampers shall modulate closed proportionately as the outside air and exhaust air dampers modulate open. If the outside air damper is 100% open and there is a further rise in temperature above supply air temperature setpoint, the outside
air damper shall remain 100% open and the chilled water valve shall modulate open as necessary to maintain the supply air temperature setpoint.

5. When economizer mode is not available, the chilled water valve and steam/hot water valve shall modulate in sequence as necessary to maintain the supply air temperature setpoint. The steam/hot water valve shall modulate as necessary to maintain a minimum preheat coil discharge air temperature setpoint of 45°F (adj.).

6. If the preheat coil is equipped with face and bypass dampers, the following sequence of operation shall apply. If the outside air temperature is above 45°F (adj.), the face and bypass dampers shall be positioned to allow full flow over the preheat coil and the steam/hot water valve shall modulate as necessary to maintain setpoint. If the outside air temperature is below 45°F (adj.), the steam/hot water valve shall be fully open and the face and bypass dampers shall modulate as necessary to maintain setpoint.

7. The humidifier control valve shall modulate as necessary to maintain the return air humidity setpoint. If the supply air humidity rises above the high limit setpoint (adj.), the humidifier valve shall modulate closed as necessary to maintain the high limit setpoint. The humidifier valve shall not fully close upon reaching the high limit setpoint. The humidifier shall normally be located between the preheat and cooling coils.

8. If the return air humidity rises above the dehumidification setpoint of 60% RH (adj.), the chilled water valve shall be overridden open as necessary to maintain the return air humidity setpoint of 50% (adj.).

9. The outside air, return air, and exhaust air dampers shall be overridden as necessary to maintain the mixed air low limit setpoint.

10. Where appropriate on a job-by-job basis: The outside air and exhaust air dampers shall be overridden open as necessary to maintain each individual space carbon dioxide level at the space carbon dioxide setpoint. The space carbon dioxide level setpoint shall be equal to 700 ppm (adj.). The return air damper shall modulate closed proportionately as the outside air and exhaust air dampers modulate open. (program sequence but lock out if space carbon dioxide sensors do not exist at time of installation of the air handling unit)

11. The supply air temperature setpoint shall be reset from 55°F (adj.) to 65°F (adj.) linearly as the return air temperature decreases from 75°F (adj.) to 65°F (adj.).
D. Unoccupied Mode

1. The supply and return/exhaust fans shall remain off. The return air damper shall open and the outside air and exhaust air dampers shall close. All isolation dampers shall close. The chilled water valve shall close and the steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 45°F (adj.). The humidifier control valve shall remain closed.

2. If the return air temperature or any space temperature falls below 60°F (adj.), the unit shall run as per warm-up mode until the return air temperature or space temperature exceeds 64°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

3. If the return air temperature or any space temperature rises above 80°F (adj.), the unit shall run as per cool-down mode until the return air temperature or space temperature falls below 76°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

E. Provide the following points hardwired to the BMS:

1. AI – Filter differential pressure (via differential pressure transmitter).

2. AI – Mixed air temperature.

3. AI – Preheat coil discharge air temperature.

4. AI – Return air humidity.

5. AI – Return air temperature.

6. AI – Return or Space carbon dioxide level.

7. AI – Supply air humidity.

8. AI – Supply air temperature.

9. AO – Chilled water valve control (0-100%).

10. AO – Hot water valve control (0-100%).

11. AO – Humidifier valve control (0-100%).
12. AO – Outside air, exhaust air and return air damper control (0-100%).

13. AO – Steam valve control (0-100%).

14. DI – Exhaust fan low intake pressure switch status.

15. DI – Exhaust fan status (via current sensing relay).

16. DI – Freezestat status.

17. DI – Leak detector status.

18. DI – Return fan low intake pressure switch status.

19. DI – Return fan status (via current sensing relay).

20. DI – Supply fan high discharge pressure switch status.


22. DO – Exhaust fan command (enable/disable).

23. DO – Return fan command (enable/disable).

24. DO – Supply fan command (enable/disable).

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AHU command (enable/disable).

2. AHU mode (warm-up, cool-down, economizer, normal, etc.)

3. Dehumidification mode (on/off).

4. Dehumidification setpoint.

5. Dirty filter alarm (indicated if filter differential pressure exceeds 1” (adj.).)

6. Economizer available.

7. Exhaust fan failure.
8. Exhaust fan low intake pressure alarm.
10. High and low preheat coil discharge air temperature alarms.
11. High and low return air humidity alarms.
12. High and low supply air temperature alarms.
13. High space carbon dioxide level alarms.
14. High supply air humidity alarm.
15. Leak detected alarm (indicating which leak detector was activated).
17. Occupied/unoccupied preheat coil discharge air temperature setpoint.
18. Outside air enthalpy.
19. Outside air humidity (global point).
20. Outside air temperature (global point).
21. Return air enthalpy.
22. Return air humidity setpoint.
23. Return fan failure.
24. Return fan low intake pressure alarm.
25. Setback and setup temperature setpoints.
26. Space carbon dioxide level setpoint.
27. Supply air humidity high limit setpoint.
29. Supply air temperature setpoint.

30. Supply fan failure.

31. Supply fan high discharge pressure alarm.

3.6 VARIABLE AIR VOLUME 100% OUTSIDE AIR HANDLING UNITS

A. Safeties

1. The supply smoke detector shall stop the supply and exhaust fans upon the presence of smoke through the FAS.

2. A high discharge air pressure switch located downstream of the supply fan and upstream of the closest damper shall stop the supply and exhaust fans when duct pressure exceeds design. The supply and exhaust fans shall remain off until the air pressure switch is manually reset.

3. A low suction air pressure switch located upstream of the exhaust fan and downstream of the closest damper shall stop the supply and exhaust fans when duct pressure decreases design.

4. A freezestat installed on the discharge of the cooling coil shall disable the unit upon sensing a temperature below 40°F (adj.). The steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 90°F (adj.).

5. Leak detectors located in the drain pans below the chilled water and humidifier coils shall sound an alarm at the BMS upon sensing water.

B. Occupied Mode

1. The air handling unit shall be started based upon a start time optimization program, time of day schedule, or manual command and run continuously.

2. Upon a command to start, the outside air damper, exhaust air damper, and all associated isolation dampers located at the unit shall open. The outside air damper, exhaust air damper, and isolation dampers shall be hardwire interlocked to the supply fan starter by the BMS contractor. Hardwired damper end switches on all two-position dampers shall energize the supply and exhaust fan starters when all associated dampers are in their fully open position.
3. Supply and exhaust fan variable frequency drives shall start unloaded and slowly ramp up to speed as required. In the occupied mode, the supply and exhaust fans run continuously. The supply fan variable frequency drive shall be controlled to maintain the supply static pressure setpoint, as sensed at a point 2/3 downstream of the supply fan. The exhaust fan variable frequency drive shall be controlled to maintain the exhaust CFM, as sensed by an exhaust airflow measuring station, at the exhaust CFM setpoint. The exhaust CFM setpoint shall be calculated by adding a fixed value (the value may be positive or negative and shall be adj.) to the supply CFM, as sensed by a supply airflow measuring station.

4. The chilled water valve and steam/hot water valve shall modulate in sequence as necessary to maintain the supply air temperature setpoint. The steam/hot water valve shall modulate as necessary to maintain a minimum preheat coil discharge air temperature setpoint of 45°F (adj.).

5. The humidifier control valve shall modulate as necessary to maintain the exhaust air humidity setpoint. If the supply air humidity rises above the high limit setpoint (adj.), the humidifier valve shall modulate closed as necessary to maintain the high limit setpoint. The humidifier valve shall not fully close upon reaching the high limit setpoint. The humidifier shall normally be located between the preheat and cooling coils.

6. If the exhaust air humidity rises above the dehumidification setpoint of 60% RH (adj.), the chilled water valve shall be overridden open as necessary to maintain the exhaust air humidity setpoint of 50% (adj.).

7. The supply static pressure setpoint shall be reset based on VAV CFM. If no VAV box is providing greater than 95% (adj.) of maximum CFM, decrease the supply air static pressure until a VAV box is providing greater than 95% (adj.) of maximum CFM. If a VAV box is providing greater than 95% (adj.) of maximum CFM and not maintaining the space temperature setpoint, increase the static pressure setpoint until the space temperature setpoint is being maintained.

C. Unoccupied Mode

1. The supply and exhaust fans shall remain off and the variable frequency drives shall be set to 0%. All two-position dampers shall close. The chilled water valve shall close and the steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 45°F (adj.). The humidifier control valve shall remain closed.
2. If any space temperature falls below 60°F (adj.), the unit shall run as per occupied mode until the space temperature exceeds 64°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

3. If any space temperature rises above 80°F (adj.), the unit shall run as per occupied mode until the space temperature falls below 76°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

D. Provide the following points hardwired to the BMS:

1. AI – Exhaust air CFM.
2. AI – Exhaust air humidity.
3. AI – Exhaust or Space carbon dioxide level.
4. AI – Filter differential pressure (via differential pressure transmitter).
5. AI – Preheat coil discharge air temperature.
6. AI – Supply air CFM.
7. AI – Supply air humidity.
8. AI – Supply air static pressure.
9. AI – Supply air temperature.
10. AO – Chilled water valve control (0-100%).
11. AO – Exhaust fan VFD speed control (0-100%).
12. AO – Hot water valve control (0-100%).
13. AO – Humidifier valve control (0-100%).
14. AO – Steam valve control (0-100%).
15. AO – Supply fan VFD speed control (0-100%).
16. DI – Exhaust fan low intake pressure switch status.

17. DI – Exhaust fan status (via current sensing relay).

18. DI – Exhaust fan VFD bypass status.

19. DI – Exhaust fan VFD common alarm.

20. DI – Freezestat status.

21. DI – Leak detector status.

22. DI – Supply fan high discharge pressure switch status.

23. DI – Supply fan status (via current sensing relay).

24. DI – Supply fan VFD bypass status.

25. DI – Supply fan VFD common alarm.

26. DO – Exhaust fan VFD command (enable/disable).

27. DO – Supply fan VFD command (enable/disable).

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AHU command (enable/disable).

2. Dehumidification mode (on/off).

3. Dehumidification setpoint.

4. Dirty filter alarm (indicated if filter differential pressure exceeds 1” (adj.).)

5. Exhaust air CFM setpoint.

6. Exhaust air humidity setpoint.

7. Exhaust fan failure.

8. Exhaust fan low intake pressure alarm.
10. High and low exhaust air CFM alarms.
11. High and low exhaust air humidity alarms.
12. High and low preheat coil discharge air temperature alarms.
13. High and low supply air static pressure alarms.
14. High and low supply air temperature alarms.
15. High space carbon dioxide level alarms.
16. High supply air humidity alarm.
17. Leak detected alarm (indicating which leak detector was activated).
18. Occupied/unoccupied preheat coil discharge air temperature setpoint.
19. Outside air temperature (global point).
21. Space carbon dioxide level setpoint.
22. Supply air humidity high limit setpoint.
23. Supply air static pressure reset parameters.
24. Supply air static pressure setpoint.
27. Supply fan failure.
28. Supply fan high discharge pressure alarm.

3.7 CONSTANT AIR VOLUME 100% OUTSIDE AIR HANDLING UNITS
A. Safeties

1. The supply smoke detector shall stop the supply and exhaust fans upon the presence of smoke through the FAS.

2. A high discharge air pressure switch located downstream of the supply fan and upstream of the closest damper shall stop the supply and exhaust fans when duct pressure exceeds design. The supply and exhaust fans shall remain off until the air pressure switch is manually reset.

3. A low suction air pressure switch located upstream of the exhaust fan and downstream of the closest damper shall stop the supply and exhaust fans when duct pressure decreases design.

4. A freezestat installed on the discharge of the cooling coil shall disable the unit upon sensing a temperature below 40°F (adj.). The steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 90°F (adj.).

5. Leak detectors located in the drain pans below the chilled water and humidifier coils shall sound an alarm at the BMS upon sensing water.

B. Occupied Mode

1. The air handling unit shall be started based upon a start time optimization program, time of day schedule, or manual command and run continuously.

2. Upon a command to start, the outside air damper, exhaust air damper, and all associated isolation dampers located at the unit shall open. The outside air damper, exhaust air damper, and isolation dampers shall be hardwire interlocked to the supply fan starter by the BMS contractor. Hardwired damper end switches on all two-position dampers shall energize the supply and exhaust fan starters when all associated dampers are in their fully open position.

3. In the occupied mode, the supply and exhaust fans run continuously.

4. The chilled water valve and steam/hot water valve shall modulate in sequence as necessary to maintain the supply air temperature setpoint. The steam/hot water valve shall modulate as necessary to maintain a minimum preheat coil discharge air temperature setpoint of 45°F (adj.).
5. The humidifier control valve shall modulate as necessary to maintain the exhaust air humidity setpoint. If the supply air humidity rises above the high limit setpoint (adj.), the humidifier valve shall modulate closed as necessary to maintain the high limit setpoint. The humidifier valve shall not fully close upon reaching the high limit setpoint. The humidifier shall normally be located between the preheat and cooling coils.

6. If the exhaust air humidity rises above the dehumidification setpoint of 60% RH (adj.), the chilled water valve shall be overridden open as necessary to maintain the exhaust air humidity setpoint of 50% (adj.).

7. The supply air temperature setpoint shall be reset from 55°F (adj.) to 65°F (adj.) linearly as the exhaust air temperature decreases from 75°F (adj.) to 65°F (adj.).

C. Unoccupied Mode

1. The supply and exhaust fans shall remain off and the variable frequency drives shall be set to 0%. All two-position dampers shall close. The chilled water valve shall close and the steam/hot water valve shall modulate as necessary to maintain a preheat coil discharge air temperature of 45°F (adj.). The humidifier control valve shall remain closed.

2. If any space temperature falls below 60°F (adj.), the unit shall run as per occupied mode until the space temperature exceeds 64°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

3. If any space temperature rises above 80°F (adj.), the unit shall run as per occupied mode until the space temperature falls below 76°F (adj.). The unit shall run a minimum of ½ hour (adj.) after start up. (verify with facility personnel whether or not this sequence is needed)

D. Provide the following points hardwired to the BMS:

1. AI – Exhaust air humidity.

2. AI – Exhaust or Space carbon dioxide level.

3. AI – Filter differential pressure (via differential pressure transmitter).

4. AI – Preheat coil discharge air temperature.
5. AI – Supply air humidity.
6. AI – Supply air temperature.
7. AO – Chilled water valve control (0-100%).
8. AO – Hot water valve control (0-100%).
9. AO – Humidifier valve control (0-100%).
10. AO – Steam valve control (0-100%).
11. DI – Exhaust fan low intake pressure switch status.
12. DI – Exhaust fan status (via current sensing relay).
13. DI – Freezestat status.
14. DI – Leak detector status.
15. DI – Supply fan high discharge pressure switch status.
16. DI – Supply fan status (via current sensing relay).
17. DO – Exhaust fan command (enable/disable).
18. DO – Supply fan command (enable/disable).

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AHU command (enable/disable).
2. Dehumidification mode (on/off).
3. Dehumidification setpoint.
4. Dirty filter alarm (indicated if filter differential pressure exceeds 1” (adj.)).
5. Exhaust air humidity setpoint.
7. Exhaust fan low intake pressure alarm.

8. Freeze stat alarm.

9. High and low exhaust air humidity alarms.

10. High and low preheat coil discharge air temperature alarms.

11. High and low supply air temperature alarms.

12. High space carbon dioxide level alarms.

13. High supply air humidity alarm.

14. Leak detected alarm (indicating which leak detector was activated).

15. Occupied/unoccupied preheat coil discharge air temperature setpoint.

16. Outside air temperature.

17. Setback and setup temperature setpoints.

18. Space carbon dioxide level setpoint.

19. Supply air humidity high limit setpoint.


22. Supply fan failure.

23. Supply fan high discharge pressure alarm.

3.8 HEATING AND VENTILATING UNITS

A. Safeties

1. The supply smoke detector shall stop the supply fan upon the presence of smoke through the FAS.

2. A high discharge air pressure switch located downstream of the supply fan and upstream of the closest damper shall stop the supply fan when duct pressure exceeds design. The supply fan shall remain off until the air pressure switch is manually reset.
3. A freezestat installed on the discharge of the heating coil shall disable the unit upon sensing a temperature below 40°F (adj.).

4. A leak detector located in the drain pan below the unit shall sound an alarm at the BMS upon sensing water.

B. Occupied Mode

1. The air handling unit shall be started based upon a start time optimization program, time of day schedule, or manual command and run continuously.

2. Upon a command to start, the outside air damper and all associated isolation dampers located at the unit shall open. Outside air and isolation dampers shall be hardwire interlocked to the supply fan starter by the BMS contractor. Hardwired damper end switches on all two-position dampers shall energize the supply fan starter when all associated dampers are in their fully open position.

3. In the occupied mode, the supply fan runs continuously.

4. The steam/hot water heating valve shall modulate as necessary to maintain the supply air or space temperature setpoint.

5. If the heating coil is equipped with face and bypass dampers, the following sequence of operation shall apply. If the outside air temperature is above 45°F (adj.), the face and bypass dampers shall be positioned to allow full flow over the heating coil and the steam/hot water heating valve shall modulate as necessary to maintain setpoint. If the outside air temperature is below 45°F (adj.), the steam/hot water heating valve shall be fully open and the face and bypass dampers shall modulate as necessary to maintain setpoint.

C. Unoccupied Mode

1. The supply shall remain off. All two-position dampers shall close. The steam/hot water heating valve shall modulate as necessary to maintain a heating coil discharge air temperature of 45°F (adj.).

D. Provide the following points hardwired to the BMS:

1. Al – Filter differential pressure (via differential pressure transmitter).

2. Al – Heating coil discharge air temperature.
3. AI – Space temperature.
4. AI – Supply air temperature.
5. AO – Hot water valve control (0-100%).
6. AO – Steam valve control (0-100%).
7. DI – Freezestat status.
8. DI – Leak detector status.
9. DI – Supply fan high discharge pressure switch status.
10. DI – Supply fan status (via current sensing relay).
11. DO – Supply fan command (enable/disable).

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:
1. AHU command (enable/disable).
2. Dirty filter alarm (indicated if filter differential pressure exceeds 1” (adj.)).
3. Freezestat alarm.
4. High and low heating coil discharge air temperature alarms.
5. High and low space temperature alarms.
6. High and low supply air temperature alarms.
7. Leak detected alarm.
8. Occupied/unoccupied heating coil discharge air temperature setpoint.
9. Outside air temperature (global point).
10. Space temperature setpoint.
11. Supply air temperature setpoint.

13. Supply fan high discharge pressure alarm.

3.9 FAN COIL UNITS

A. The following alternatives shall be available for Fan Coil Units on a job-by-job basis:

1. Fan coil units shall be purchased with factory mounted Direct Digital Controls (DDC) that communicate via BACnet or Modbus.

2. Fan coil units shall be purchased with no controls. The BMS Contractor shall field install their controls, which will be equipped with BACnet communications.

3. Fan coil units shall have standalone thermostats installed in field (i.e. no integration to the BMS).

B. Safeties

1. A water leak detector located in the unit drain pan shall indicate an alarm at the BMS whenever water is detected.

C. Enabled Mode

1. The fan coil unit shall be started based upon a start time optimization program, time of day schedule or manual command.

2. The supply fan shall run continuously.

3. The coil valve shall modulate as necessary to maintain the space temperature setpoint. The unit shall operate in cooling mode when the supply water temperature is below 50°F (adj.) and shall operate in heating mode when the supply water temperature is above 50°F (adj.) plus a differential.

4. In cooling mode, the coil valve shall modulate open upon a rise in space temperature above setpoint and shall modulate closed upon a fall in space temperature below setpoint. In heating mode, the coil valve shall modulate open upon a fall in space temperature below setpoint and shall modulate closed upon a rise in space temperature above setpoint.

D. Disabled Mode
1. The supply fan shall remain de-energized. The coil valve shall remain closed.

2. If the space temperature rises above 80°F (adj.), the unit shall operate as per enabled mode until the space temperature falls below 76°F (adj.). The unit shall run a minimum of 1/2 hour after start up.

3. If the space temperature falls below 60°F (adj.), the fan coil unit shall operate as per occupied mode until the space temperature exceeds 64°F (adj.). The unit shall run a minimum of 1/2 hr (adj.) after start up.

4. The fan coil DDC controller shall be programmed for occupancy override. When occupancy override is activated via a pushbutton on the space temperature sensor or via a BMS command, the fan coil shall control as per enabled mode and as per the occupied cooling setpoint. The fan coil shall operate in occupancy override mode for a period of 2 hours (adj.).

5. The following points shall be hardwired to the BMS:
   a. AI – Space temperature.
   b. AI – Supply water temperature (via strap on sensor).
   c. AO – Coil valve control (0-100%).
   d. DI – Leak detector status.
   e. DI – Supply fan status (via current sensing relay).
   f. DO – Supply fan command.

6. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:
   a. Heating/cooling mode.
   b. Heating/cooling space temperature setpoints.
   c. High and low space temperature alarms.
   d. Leak detected alarm.
e. Occupancy override status.

f. Space/area served.

g. Supply fan failure.

h. Supply water temperature switchover setpoint.

i. Unit enable/disable.

3.10 VARIABLE AIR VOLUME (VAV) BOXES WITH HOT WATER REHEAT

A. Coordinate factory mounting and wiring of Control Panel, actuator, transformer and hot water valve with the VAV box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed, or wired by others that are required for an operational system.

B. Occupied Mode

1. Upon a fall in space temperature below setpoint, the box damper shall modulate closed to the minimum CFM setpoint. Upon a further fall in space temperature, the box damper shall modulate to the heating CFM setpoint and the hot water reheat valve shall modulate as necessary to maintain the space temperature setpoint. Upon a rise in space temperature, the hot water reheat valve shall close. Upon a further rise in space temperature, the box damper shall modulate from the minimum to the maximum CFM setting as necessary to maintain the CFM setpoint as reset by the space temperature. The minimum and maximum CFM settings shall be those scheduled on the mechanical drawings.

C. Unoccupied Mode

1. The VAV box damper shall close and the reheat valve shall remain closed.

2. If the space temperature falls below the unoccupied setback temperature setpoint of 60°F (adj.) or rises above the unoccupied setup temperature setpoint of 80°F (adj.), the fan system serving the VAV box shall be enabled and the VAV box shall be indexed to the maximum CFM setting. The fan system shall run for a minimum of 1/2 hour (adj.).

3. The VAV DDC controller shall be programmed for occupancy override. By depressing the occupancy override button located on the space temperature sensor, the VAV box...
shall be restored to the occupied temperature setpoint and the fan system serving the VAV shall be energized.

4. The VAV box shall not open beyond the maximum CFM setting. Provide one (1) DDC controller and one (1) temperature sensor for each VAV box.

D. Provide the following points hardwired to the BMS:

1. AO – Damper control (0-100%).
2. AO – Reheat valve control (0-100%).
3. AI – Space temperature.
4. AI – Supply air CFM.

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.
2. Box K factor.
3. High and low space temperature alarms.
5. Occupied/unoccupied command.
6. Occupied/unoccupied, heating/cooling temperature setpoints.
7. Space/area served.
8. Supply air CFM setpoint.

3.11 VARIABLE AIR VOLUME (VAV) BOXES

A. Coordinate factory mounting and wiring of secondary control panel and actuator with the VAV box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed or wired by others that are required for an operational system.

B. Occupied Mode
1. Upon a fall in space temperature below setpoint, the box damper shall modulate closed to the minimum CFM setpoint. Upon a rise in space temperature, the box damper shall modulate from the minimum to the maximum CFM setting as necessary to maintain the CFM setpoint as reset by the space temperature. The minimum and maximum CFM settings shall be those scheduled on the mechanical drawings.

C. Unoccupied Mode

1. When the primary fan system serving the VAV box is not running, the VAV box damper shall close.
2. If the space temperature falls below the unoccupied setback temperature setpoint of 60°F (adj.) or rises above the unoccupied setup temperature setpoint of 80°F (adj.), the fan system serving the VAV box shall be enabled and the VAV box shall be indexed to the maximum CFM setting. The fan system shall run for a minimum of 1/2 hour (adj.).
3. The VAV DDC controller shall be programmed for occupancy override. By depressing the occupancy override button located on the space temperature sensor, the VAV box shall be restored to the occupied temperature setpoint and the fan system serving the VAV shall be energized.

D. The VAV box shall not open beyond the maximum CFM setting. Provide one (1) DDC controller and one (1) temperature sensor for each VAV box.

E. Provide the following points hardwired to the BMS:

1. AO – Damper control (0-100%).
2. AI – Space temperature.
3. AI – Supply air CFM.

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.
2. Box K factor.
3. High and low space temperature alarms.
5. Occupied/unoccupied command.
6. Occupied/unoccupied, heating/cooling temperature setpoints.

7. Space/area served.

8. Supply air CFM setpoint.

3.12 CONSTANT AIR VOLUME (CAV) BOXES WITH HOT WATER REHEAT
A. Coordinate factory mounting and wiring of secondary control panel, actuator and hot water valve with the VAV box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed or wired by others that are required for an operational system.

B. Occupied Mode

1. The CAV box damper shall modulate as necessary to maintain the CFM setpoint. The CAV box hot water reheat valve shall modulate as necessary to maintain the space temperature setpoint. The CFM setpoint shall be as scheduled on the mechanical drawings.

C. Unoccupied Mode

1. When the primary fan system serving the CAV box is not running, the CAV box damper shall close and the reheat valve shall remain closed.

2. If the space temperature falls below the unoccupied setback temperature setpoint of 60°F (adj.) or rises above the unoccupied setup temperature setpoint of 80°F (adj.), the fan system serving the CAV box shall be energized and the CAV box shall control as described in occupied mode, however the box shall control for the unoccupied temperature setpoint. The fan system shall run for a minimum of 1/2 hour (adj.).

3. The CAV DDC controller shall be programmed for occupancy override. By depressing the occupancy override button located on the space temperature sensor, the CAV box shall be restored to the occupied temperature setpoint and the fan system serving the CAV shall be energized.

D. Provide one (1) DDC controller and one (1) temperature sensor for each CAV box.

E. Provide the following points hardwired to the BMS:

1. AO – Damper control (0-100%).

2. AO – Reheat valve control (0-100%).

3. AI – Space temperature.
4. AI – Supply air CFM.

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.

2. Box K factor.

3. High and low space temperature alarms.


5. Occupied/unoccupied command.

6. Occupied/unoccupied, heating/cooling temperature setpoints.

7. Space/area served.

8. Supply air CFM setpoint.

3.13 CONSTANT AIR VOLUME (CAV) BOXES

A. Coordinate factory mounting and wiring of secondary control panel, actuator and transformer with the box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed or wired by others that are required for an operational system.

B. Occupied Mode

1. The CAV box damper shall modulate as necessary to maintain the CFM setpoint. The CFM setpoint shall be as scheduled on the mechanical drawings.

C. Unoccupied Mode

1. When the primary fan system serving the CAV box is not running, the CAV box damper shall close.

2. The CAV DDC controller shall be programmed for occupancy override. By depressing the occupancy override button located on the space temperature sensor, the CAV box shall be restored to the occupied temperature setpoint and the fan system serving the CAV shall be energized.

D. Provide one (1) DDC controller for each box.
E. Provide the following points hardwired to the BMS:

1. AO – Damper control (0-100%).
2. AI – Supply air CFM.

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.
2. Box K factor.
3. High and low space temperature alarms.
5. Occupied/unoccupied command.
6. Space/area served.
7. Supply air CFM setpoint.

3.14 TRACKING SUPPLY AND EXHAUST BOXES SERVING SPACES WITHOUT FUME HOODS

A. Coordinate factory mounting and wiring of controller and actuator with the manufacturer. The BMS contractor shall be responsible for furnishing, installing, and wiring of controls not furnished, installed, or wired by others that are required for an operational system. The BMS contractor shall be responsible for running power wiring to all tracking pairs.

B. The tracking system measures the supply and exhaust flows into and out of the space. Supply air flow is varied to maintain a fixed offset air volume differential between the supply and total exhaust in a closed loop tracking arrangement. A space temperature sensor and a duct mounted temperature sensor are inputs to an anticipatory temperature control proportional/integral/derivative (PID) loop.

C. Occupied Mode

1. Each tracking pair shall be enabled/disabled based upon a time of day schedule or manual command.
2. The supply and total exhaust air volumes from the space shall be controlled (varied) in such a manner as to perform both air flow volume (mass) and air flow temperature (energy) calculations and adjustments.

3. Space supply air volume shall be controlled to maintain space comfort conditions or to maintain the required air volume offset between the supply and exhaust air volumes.

4. When the supply air volume required for makeup exceeds the volume required for space comfort conditions, the control system shall modulate the general exhaust damper to its closed position. If additional makeup air is still required, the supply air volume will be increased as required to maintain the volume differential between the supply air and exhaust air. The temperature of the supply and exhaust air, along with their respective air volumes, will be measured and input into the controller. The controller will adjust the heating valve on the reheat coil based on those inputs as well as an input from a space temperature sensor, as required to perform an energy balance in the space. The controller program shall be adjusted and calibrated to each space it serves to perform the mass and energy calculations and adjustments without noticeable swings in space temperature.

5. If a supply box serves a space also served by fin tube radiation, the fin tube radiation shall be connected to the tracking pair controller and shall operate in sequence with the boxes. The fin tube radiation shall be utilized as the first source of heating. The supply box damper shall be at minimum position and the radiation valve shall modulate as necessary to maintain the space temperature setpoint. If the radiation valve is 100% open and additional heating is required, the radiation valve shall remain 100% open and the reheat valve shall modulate as necessary to maintain the space temperature setpoint. The reheat valve shall modulate fully closed before the radiation valve closes beyond 100%. The supply box shall remain at minimum position until the radiation valve is fully closed.

6. The minimum and maximum CFM settings shall be those scheduled on the mechanical drawings.

D. Unoccupied Mode

1. If the air handling unit serving the tracking pair is disabled, the supply and exhaust box dampers and the reheat valve shall remain closed

2. If the air handling unit serving the tracking pair is enabled but the space is indexed to unoccupied mode, the supply and exhaust box dampers shall remain at minimum
position. The reheat valve shall modulate as necessary to maintain the unoccupied space temperature setpoint.

3. If the air handling unit serving the tracking pair is enabled due to the area served by the unit becoming too warm or cool, a sufficient quantity of boxes shall be enabled to allow the air handling unit fan to operate at minimum speed. The boxes serving the spaces that have become too warm or cool shall be included in the boxes that are enabled.

4. The DDC controller shall be programmed for occupancy override. By depressing the occupancy override button located on the space temperature sensor, the tracking pair shall be restored to the occupied temperature setpoint and the fan system serving the tracking pairs shall be enabled.

E. Disabled Mode

1. The supply and exhaust box dampers and the reheat valve shall remain closed.

F. Coordinate spaces to be provided with occupancy override capability with the Owner.

G. The supply and exhaust boxes shall not open beyond the maximum CFM setting. Provide one DDC controller and one temperature sensor for each tracking pair.

H. Provide the following points hardwired to the BMS:

1. Al – Exhaust CFM.
2. Al – Fume hood exhaust CFM.
3. Al – Space temperature.
4. Al – Supply air CFM.
5. Ao – Hot water reheat control (0-100%).
6. Ao – Exhaust box damper control (0-100%).
7. Ao – Radiation valve control (0-100%; where applicable).
8. Ao – Supply box damper control (0-100%).
Sequence of Operations

I. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Exhaust CFM setpoint.
2. High and low space temperature alarms.
3. Individual box K factor.
5. Occupied/unoccupied command.
6. Occupied/unoccupied, heating/cooling space temperature setpoints.
7. Space/area served.
8. Supply air CFM setpoint.

3.15 GENERAL EXHAUST FANS

A. The exhaust fan shall be started/stopped manually at the local motor starter and run continuously. A BMS alarm shall sound when the exhaust fan stopped.

B. Upon a command to start the fan, the fan discharge damper shall open (if applicable). When the damper is open, as sensed by a damper end switch, the fan shall energize. Upon a command to de-energize the fan, the discharge damper shall have an adjustable time delay to keep the damper open up to 30 seconds after the fan is de-energized.

C. Provide the following points hardwired to the BMS:

1. DI – Individual fan status (via current sensing relay).

D. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Fan stopped alarm.
2. Space/area served.
3.16 TOILET EXHAUST FANS

A. Toilet exhaust fans shall be controlled either manually (#1 below) or via an occupancy sensor (#2 below) and shall be specified on a job-by-job basis:

1. The exhaust fan shall be started/stopped manually at the local motor starter and run continuously. A BMS alarm shall sound when the exhaust fan stopped (if applicable).

2. The fan shall run whenever the facility is occupied. The fan shall be de-energized whenever the facility is unoccupied. The occupancy sensor time delay shall be set to 15 minutes (adj.).

B. Provide the following points:

1. DI - Exhaust fan status (via current sensing relay).

C. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Fan stopped alarm.

2. Space/area served.

3.17 TEMPERATURE CONTROLLED EXHAUST FANS

A. The fan shall be energized whenever the space temperature rises above the space temperature setpoint of 80°F (adj.). Fan shall be de-energized when space temperature is at or below setpoint.

B. The exhaust fan VFD shall operate at a preset speed determined during balancing.

C. Provide the following points:

1. AI - Space temperature.

2. AO - Exhaust fan VFD speed control (0-100%).

3. DI - Exhaust fan status (via current sensing relay).

4. DO - Exhaust fan VFD command.

3.18 FUME HOOD EXHAUST FANS
A. The exhaust fan shall be started/stopped manually at the local motor starter. A BMS alarm shall sound when the exhaust fan stopped.

B. Provide the following points hardwired to the BMS:
   1. DI – Individual exhaust fan status (via current sensing relay).
   2. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:
      3. Exhaust fan stopped alarm.
      4. Space/area served.

3.19 FIN TUBE RADIATION/RADIANT PANELS – STANDALONE

A. Radiation panels that are not associated with a VAV box serving the same space shall be controlled by a thermostat.

B. During occupied mode, the radiation valve shall modulate as necessary to maintain the space temperature setpoint. During unoccupied mode, the radiation valve shall modulate as necessary to maintain the night setback space temperature setpoint.

3.20 FIN TUBE RADIATION/RADIANT PANELS ASSOCIATED WITH A VAV BOX

A. Fin tube radiation/radiant panels associated with a VAV box serving the same space shall be integrated to the BMS.

B. If a space is served by radiation and a VAV box, the radiation shall be utilized as the first source of heating and shall not be brought on unless the VAV box damper is at minimum position. The VAV box damper shall not open beyond minimum position until the radiation valve is fully closed. The VAV box hot water valve shall not open unless the radiation valve is fully open. The radiation valve shall be fully open any time the VAV box hot water valve is open.

C. Provide the following points hardwired to the BMS:
   1. AI – Space temperature.
   2. AO – Radiation valve control (0-100%).
D. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. High and low space temperature alarms.
2. Occupied/unoccupied command.
3. Occupied/unoccupied space temperature setpoints.
4. Space/area served.

3.21 UNIT HEATERS

A. On a fall in space temperature below setpoint, the thermostat shall energize the unit fan and open the control valve to maintain the space temperature setpoint. On a rise in space temperature, the fan shall be de-energized and the control valve shall remain closed.

B. A pipe-mounted electric aquastat shall lock out the fan if hot water is not available.

3.22 CABINET UNIT HEATERS

A. The BMS contractor shall furnish, install and wire a space thermostat to control the unit heater and any other devices required to complete the sequence of operation including, but not limited to, control relays.

B. On a fall in space temperature below setpoint, the thermostat shall energize the unit fan to maintain the space temperature setpoint. On a rise in space temperature, the fan shall be de-energized. The units shall operate independent of the BMS.

C. A pipe-mounted electric aquastat shall lock out the fan if steam or hot water is not available.

3.23 STEAM PRESSURE REDUCING STATIONS

A. The BMS shall monitor each steam pressure reducing station. The BMS contractor shall furnish, wire, install and commission pressure transmitters to monitor the points indicated below.

B. Provide the following points hardwired to the BMS:

1. AI – Steam pressure reducing station entering high pressure.
2. AI – Steam pressure reducing station medium pressure.

3. AI – Steam pressure reducing station discharge pressure.

C. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:
   1. Steam pressure reducing station high and low entering pressure alarms.
   2. Steam pressure reducing station high and low medium pressure alarms.
   3. Steam pressure reducing station high and low discharge pressure alarms.

3.24 CONDENSATE PUMP

A. The BMS shall monitor the high level alarm for the condensate pump from the manufacturer local control panel. The BMS contractor shall coordinate the point monitoring with manufacturer as necessary.

B. Provide the following points hardwired to the BMS:
   1. DI - High level alarm.

3.25 AIR COMPRESSOR MONITORING

A. The BMS contractor shall furnish, install, wire and commission a pressure transmitter in the inlet line and the discharge line of the air compressor.

B. Provide the following points hardwired to the BMS:
   1. AI – Discharge pressure.
   2. AI – Inlet pressure.

C. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:
   1. High and low discharge pressure alarms.
   2. High and low inlet pressure alarms.
3.26 HEAT TRACING

A. Provide the following points hardwired to the BMS:
   1. DI – Common alarm (if available from heat trace manufacturer provided controls).
   2. DI – Heat tracing on/off status (as sensed by a current sensing relay; install one (1) per
      heat tracing circuit and each current sensing relay shall be an individual input to the
      BMS).

B. Provide the following points on the associated equipment graphic in addition to the
   hardwired points indicated above:
   1. Failure alarm (indicated if outside air temperature is less than 40°F (adj.) and the heat
      tracing status is off).

3.27 FIRE/SMOKE DAMPERS

A. Fire/smoke dampers shall remain open during normal operation.

B. All fire/smoke dampers shall be interlocked with their respective fan system and/or to the
   building fire alarm control panel to open and close as required with fan operation, panel
   requirement, local smoke detection, or as required by the fire alarm system, including smoke
   purge.

C. FSD’s shall have a dedicated end switch that allows for feedback to the BMS indicating
   open and close position.

D. FSD’s shall have a dedicated end switch that allows for feedback to the FAS indicating open
   and close position.

E. Coordinate all requirements with the FAS contractor.

3.28 VARIABLE FREQUENCY DRIVES

A. The BMS contractor shall provide all required interconnecting control wiring to interface the
   variable frequency drives and the associated equipment to the BMS.

B. Provide all required wiring from the motor winding heaters to each drive.

C. Provide the following points hardwired to the BMS:
Sequence of Operations

1. AO – VFD speed control (0-100%).

2. DI – VFD common alarm.

3. DI – VFD status (via current sensing relay, monitoring VFD status is not acceptable).

4. DO – VFD command (enable/disable).

D. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. VFD failure.

3.29 AUTOMATIC RESTART SEQUENCE

A. The BMS contractor shall submit an automatic restart sequence of operation that prioritizes the loads to be restarted, in order of importance, when a changeover in power occurs, either from normal power to emergency power or from emergency power to normal power and when there is more than one (1) piece of mechanical equipment to start at the same time (e.g., at the beginning of a normally scheduled occupied cycle). The automatic restart sequence of operation shall also show the time delays between the startup of each piece of mechanical equipment.

B. Simultaneous starting of motors shall be prevented by a sequential start program in the DDC system. This program shall also provide sequential restart after power failure of motors that were running prior to power failure.

C. Software time delay relays shall be provided in the DDC system to allow fan motors to cool down before restarting. Motors shall have both a minimum interval time (between consecutive starts) and a minimum off time (between stop and start). The time periods shall be based on motor HP per the following table.

D. Time periods are in minutes.

1. Motor Horsepower
   - 1/4-10
   - 10-20
   - 20-50
2. Minimum Interval Time
   10
   20
   30

3. Minimum Off Time (adj.)
   3
   5
   7

E. Automatic restart of fans after a safety shutdown trip shall be software prohibited through the de-energization of the remote start/stop contact. Fan restart shall be manually initiated by the operator either locally or remotely through a computer workstation after resolving the cause for shutdown.

F. Operator Workstation: Display the following data:
   1. Individual minimum interval time for each piece of mechanical equipment.
   2. Individual minimum off time for each piece of mechanical equipment.
   3. Individual motor horsepower.
   4. Individual restart delay for each piece of mechanical equipment.

END OF SECTION 230993
SECTION 231113 - FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This Section includes fuel-oil and diesel-fuel-oil distribution systems and the following:

1. Pipes, tubes, and fittings.
2. Piping and tubing joining materials.
3. Piping specialties.
4. Valves.
5. Vertical, steel, fuel-oil ASTs.
6. Horizontal, steel, fuel-oil ASTs.
7. Containment-dike, steel, fuel-oil ASTs.
8. Insulated, steel, fuel-oil ASTs.
9. Concrete-vaulted, steel, fuel-oil ASTs.
10. Steel, fuel-oil USTs with STI-P3.
11. Composite, steel, fuel-oil USTs.
13. FRP fuel-oil USTs.
15. Fuel-oil UST accessories.
16. Fuel-oil storage tank piping specialties.
17. Fuel-oil storage tank pumps.
18. Fuel-transfer pumps.
19. Fuel maintenance system.
20. Liquid-level gage system.
21. Leak-detection and monitoring system.
22. Mechanical sleeve seals.
23. Grout.
24. Concrete bases.

B. This contractor shall provide all device, piping valves, relays, end switches, control components, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operations for the specified equipment and thereby provide a fully operational system.

1.2 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.

F. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Also include, where
applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Piping specialties.

2. Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.

3. Each type and size of fuel-oil storage tank. Indicate dimensions, weights, loads, components, and location and size of each field connection.

4. Fuel-oil storage tank accessories.

5. Fuel-oil storage tank piping specialties.

6. Fuel-oil storage tank pumps.

7. Fuel-oil transfer pumps.

8. Fuel maintenance system.

9. Liquid-level gage system.

10. Leak-detection and monitoring system.

B. Shop Drawings: For facility fuel-oil piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.

2. For fuel-oil storage tanks and pumps, include details of supports and anchors.

C. Site Survey: Plans, drawn to scale, on which fuel-oil piping and tanks are shown and coordinated with other services and utilities.

D. Qualification Data: For qualified professional engineer.

E. Seismic Qualification Certificates: For ASTs, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Brazing certificates.

G. Welding certificates.

H. Field/Factory quality-control and test reports.

I. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

J. Warranty: Sample of special warranty.

1.4 RESILIENCY

A. Underground Fuel Storage shall be anchored and design and installed to prevent flotation, collapse, and lateral movement from hydrostatic forces. Additional capacity and storage location requirements per NYC BC G307 and G310.6 and G304.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. See Part 3 piping schedule articles for where pipes, tubes, fittings, and joining materials are applied in various services.

B. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type S, Grade B.
      a. Screwed with exterior shoulder weld.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil. Rated for 1,000 deg F.
   e. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves

6. Above ground: Two coats of rust inhibiting paint and one coat of finish paint in color to be approved by Owner.

7. Exposed to freezing: Insulate with aluminum jacket and heat tracing as required.

8. Outer conduit (sleeve) for enclosing oil lines outside of rated shafts above lowest floor of building:
   a. Fuel oil supply, return and fill:
      1) Outer pipe: Steel pipe, in accordance with ASTM A53, Schedule 10, seamless, black steel pipe, all welded construction.
      2) Utilize “spyders” to align and support inner pipe within outer pipe. “Spyders” shall be open to permit passage of oil for drainage in direction of piping pitch
   C. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type K and ASTM B 88, Type L.


D. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K and ASTM B 88, Type L.

E. Dielectric Unions
   1. Provide for all connections between dissimilar materials:
      a. To 3,000 psig working pressure at 250 deg F.
      b. Sizes:
         1) 1/2 inch to 2 inch: 175 lb. working pressure.
         2) 1/2 inch to 2-1/2 inch: 600 lb. working pressure.
         3) 1/2 inch to 3 inch: 3,000 lb. working pressure.
      c. Material:
         1) Malleable iron, ASTM 197 up to 600 lb. working pressure.
         2) Forged steel ASTM A 105 for 3,000 lb. working pressure.
      d. Threads: ANSI male or female NPT, ANSI B1.20.1 or flanged. Threaded unions to be back welded.
      e. Insulating material: Nylon modified Type 66 (black) with dielectric strength of 400 V per 0.001 inch at 0.2 percent moisture.
      f. Insulating thickness: 0.030 Inc.
      g. Design dielectric strength of union: 2,500 V.
h. Maximum test pressure:
   1) 3,000 psig at 150 deg F maximum for one minute.
   2) 4,500 psig for one minute for 3,000 lb. working pressure.

i. O ring:
   1) Neoprene, suitable for oil service.
   2) 70 durometer.
   3) ASTM D 2000-5BC715A14D14E14E34.
   4) AMS 3209.
   5) -65 deg F to 250 deg F.

2. Dielectric Flange Kit:
   a. Companion flange kit for field assembly, including flanges, full face or ring type
      neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic
      insulating washers, steel backing washers, bolts and nuts.

2.2 DOUBLE-CONTAINMENT PIPE AND FITTINGS

A. Flexible, Double-Containment Piping: Comply with UL 971.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of
      the following
      a. Environ Products, Inc.
      b. OPW.

   2. Pipe Materials: PVDF complying with ASTM D 3222 for carrier pipe with mechanical
      couplings to seal carrier, and PE pipe complying with ASTM D 4976 for containment
      piping.

   3. Fiberglass sumps.
4. Watertight sump entry boots, pipe adapters with test ports and tubes, coaxial fittings, and couplings.

5. Minimum Operating Pressure Rating: 10 psig.

6. Plastic to Steel Pipe Transition Fittings: Factory-fabricated fittings with plastic end matching or compatible with carrier piping, and steel pipe end complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

7. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

B. Rigid, Double-Containment Piping: Comply with UL 971.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. Ameron International; Fiberglass Pipe Group.
      b. Conley Corporation.
      c. Perma-Pipe, Inc.
      d. Smith Fibercast.
   2. RTRP: ASTM D 2996 or ASTM D 2997 carrier and containment piping and mechanical couplings to seal carrier and containment piping or individually bonded joints.
      a. Minimum Operating-Pressure Rating for RTRP NPS 2 and NPS 3: 150 psig.
      b. Minimum Operating-Pressure Rating for RTRP NPS 4 and NPS 6: 125 psig. Compliance with UL 971 is not required for NPS 6 and larger piping.
      c. Fittings: RTRF complying with ASTM D 2996 or ASTM D 2997, and made by RTRP manufacturer; watertight sump entry boots, termination, or other end fittings.
   3. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.
2.3 PIPING SPECIALTIES

A. Flexible Connectors: Comply with UL 567.

1. Metallic Connectors:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) American Flexible Hose Co., Inc.
      2) Flexicraft Industries.
      3) FLEX-ING, Inc.
      4) Hose Master, Inc.
      5) Metraflex Company (The).
      6) Proco Products, Inc.
      7) Tru-Flex Metal Hose Corp.
      8) Unaflex.

   b. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.

   c. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.

   d. Minimum Operating Pressure: 150 psig.

   e. End Connections: Socket, flanged, or threaded end to match connected piping.

   f. Maximum Length: 30 inches.

   g. Swivel end, 50-psi maximum operating pressure.

   h. Factory-furnished anode.

2. Nonmetallic Connectors:
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1) American Flexible Hose Co., Inc.
2) Flexicraft Industries.
3) FLEX-ING, Inc.
4) Hose Master, Inc.
5) Metraflex Company (The).
6) Tru-Flex Metal Hose Corp.

b. Listed and labeled for underground applications by an NRTL acceptable to authorities having jurisdiction.

c. PFTE bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.

d. Minimum Operating Pressure: 150 psig.

e. End Connections: Socket, flanged, or threaded end to match connected piping.

f. Maximum Length: 30 inches.

g. Swivel end, 50-psig maximum operating pressure.

h. Factory-furnished anode.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen 80-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

C. Basket Strainers:
   1. Body: ASTM A126, Class B, hightensile cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 80-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

D. T-Pattern Strainers:
   1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
   2. End Connections: Grooved ends.
   3. Strainer Screen: 80-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
   4. CWP Rating: 750 psig.

E. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 225 deg F.

2.4 JOINING MATERIALS
Joint Compound and Tape: Suitable for fuel oil.


Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.5 MANUAL FUEL-OIL SHUTOFF VALVES

A. See valve schedule in Part 3 for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with UL 842.
   1. CWP Rating: 125 psig
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
   5. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with UL 842.
   1. CWP Rating: 125 psig
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   3. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. BrassCraft Manufacturing Company; a Masco company.
   c. Lyall, R. W. & Company, Inc.
   e. Perfection Corporation; A Subsidiary of American Meter Company.


3. Ball: Chrome-plated brass.

4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.

6. Packing: Separate packnut with adjustable-stem packing threaded ends.

7. Ends: Threaded, flared, or socket as indicated in the valve schedule.

8. CWP Rating: 600 psig.

9. Service Mark: Initials "WOG" shall be permanently marked on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. BrassCraft Manufacturing Company; a Masco company.
   c. Lyall, R. W. & Company, Inc.
   e. Perfection Corporation; A Subsidiary of American Meter Company

3. Ball: Chrome-plated bronze.

4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.

6. Packing: Threaded-body packnut design with adjustable-stem packing.

7. Ends: Threaded, flared, or socket as indicated in the valve schedule.

8. CWP Rating: 600 psig.

9. Service Mark: Initials "WOG" shall be permanently marked on valve body.

F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   c. Lyall, R. W. & Company, Inc.
   e. Perfection Corporation; A Subsidiary of American Meter Company.


3. Ball: Chrome-plated bronze.

4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE.

6. Packing: Threaded-body packnut design with adjustable-stem packing.

7. Ends: Threaded, flared, or socket as indicated in the valve schedule.
8. CWP Rating: 600 psig.

9. Service Mark: Initials "WOG" shall be permanently marked on valve body.

2.6 SPECIALTY VALVES

A. Pressure Relief Valves: Comply with UL 842.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. Anderson Greenwood; Division of Tyco Flow Control.
      b. Fulflo Specialties, Inc.
      c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.

   2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

   3. Body: Brass, bronze, or cast steel.


   5. Seat and Seal: Nitrile rubber.


   9. Relief Pressure Setting: 60 psig.

B. Oil Safety Valves: Comply with UL 842.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
      a. Anderson Greenwood; Division of Tyco Flow Control.
      b. Suntec Industries Incorporated.
      c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

3. Body: Brass, bronze, or cast steel.


5. Seat and Diaphragm: Nitrile rubber.


10. Maximum Outlet Pressure: 3 psig.

C. Emergency Shutoff Valves: Comply with UL 842.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      
      a. Ameron International; Fiberglass Pipe Group.
      
      b. Conley Corporation.
      
      c. EMCO Wheaton; a Gardner Denver Company.
      
      d. Environ Products, Inc.
      
      e. OPW.

   2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

   3. Double poppet valve.


   5. Disk: FPM.
7. Stem: Plated brass.
8. O-Ring: FPM.
10. Fusible link to close valve at 165 deg F.
11. Thermal relief to vent line pressure buildup due to fire.
12. Air test port.
13. Maximum Operating Pressure: 0.5 psig.

D. Mechanical Leak Detector: Comply with UL 842.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. FE Petro, Inc.
   b. Red Jacket Pumps; a division of Veeder-Root.

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. FE Petro, Inc.
   b. Red Jacket Pumps; a division of Veeder-Root.

3. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
5. O-Rings: Elastomeric compatible with fuel oil.
6. Piston and Stem Seals: PTFE.
7. Stem and Spring: Stainless steel.
9. Indicated Leak Rate: Maximum 3 gph at 10 psig.
10. Leak Indication: Reduced flow.

2.7 FUEL OIL SPECIALTIES

A. Pressure-Reducing Valves: UL listed for fuel oil service. Include steel body with 150-psig minimum pressure rating.

B. Provide and install on the tank suction stub a bronze 1-1/2 inch double poppet foot valve with lapped-in seat, double guided poppet stems and 20 mesh monel screen. The foot valve shall come with a foot valve extractor fitting which shall allow for easy access to and repair of the foot valve. The foot valve extractor fitting shall come with an extractor wrench of the appropriate size.

C. Furnish and install inside the building at the high point of the oil suction line from each fuel oil tank at each fuel oil supply line, a U.L. listed and labeled anti-siphon valve. For New York City applications the anti-siphon valve must have an Approval number by the New York City Board of Standards and Appeals. Valve shall be sized to meet the flow requirements (several valves should be manifold together if the flow requirements exceed the valve capacity), and shall be equipped with a spring to match the vertical distance between the highest oil storage level of the main tank and the inlet to the fuel oil pumps.

D. Provide tank selector valves for manifolding of the fuel oil lines to fuel oil storage tanks. Valve shall incorporate six valve connections in a common casting with a single operating lever for tank selection and visible indication of tank use. The selector valve for the transfer set shall be manually operated.

E. Provide, where shown on drawings, a quick-closing spring loaded lever gate valve held open by a wire with a fusible link arranged so that the valve will automatically close if the link melts. End switch shall be U.L. recognized, CSA certified, rate 10 amp, 120 VAC, flexible cable actuated, utilizing a NEMA 3, 4, and 13 enclosure, require 5 oz. maximum operating force, and have silver cadmium oxide contacts. Valve shall be equipped with end switch to indicate valve position.

F. Provide at bottom of riser, where shown on the drawings, riser pipe drum with leak sensor. Open top container with 48 gallon capacity, 12 gauge steel, U.L. approved. Container shall have a factory installed rupture basin switch. Switch shall indicate the occurrence of a leak into the container. Rupture basin switch shall be redundantly sealed against vapors and fluids, be lever float operated and magnetically actuated. Wiring enclosure shall be cast.
aluminum and NEMA 4 constructed. Exterior shall be finished in oil resistant textured gray enamel. Leak sensing switch shall be wired to the fuel oil management control center as listed in this specification.

G. Furnish and install for the header a pressure switch and a compound gauge. The pressure switch is to shut off the pumps when the pressure reaches 10 psi, and the compound gauge to indicate the pressure. A 4 inch dial Preferred compound gauge shall be liquid filled to dampen pulsation, with bright finished stainless steel case, brass movement, bronze bourdon tube, and shall be furnished with a pulsation dampening orifice. Gauge shall be readable from the front of the set at a minimum distance of 20 feet. Gauge shall read 30 inch vacuum - 15 psig. Gauges shall be mounted with isolation ball valve.

H. Provide a flame arrester with vent fitting at the end of a header vent line. The combination vent and flame arrester shall be type FA/FV series 830 furnished by Preferred Utilities Mfg. Corp. or approved equal.

I. Provide a header low level alarm switch assembly with the fuel oil management control center for low level indication. Control shall have float operated switches rated at 100 watts. Unit shall be suitable for pressures to 150 psi, and shall be entirely of non-ferrous material. Electrical connections shall be made external to the header in heavy duty cast aluminum terminal enclosure.

J. In the vent line shall be installed a vent line switch to indicate the occurrence of a header overflow and signal the header high level alarm. Switch shall be mounted in tee connection as midway between the combination vent and flame arrester. Switch shall be redundant sealed against vapors and fluids, be lever float operated and magnetically actuated. Wiring enclosure shall be cast aluminum, NEMA 4, and watertight.

K. Provide at the highest point of each return line a vacuum breaker.

L. Provide at the bottom of the return pipe from a header or day tank, a diaphragm type back pressure regulating valve to stop the oil from free falling down and splashing into the main tank. Valve shall have cast iron body for pressures to 300 psi, bronze trim and neoprene diaphragm with adjustable range set at 30 psi.

M. Provide leak detection switches through the side of pump set rupture basin and at the base of each fuel oil shaft.

N. Pressure switch shall be installed in day tank to disengage pump when day tank reaches 5 psi (adj.) to prevent overpressurizing of the day tank and the emergency generator pump.
O. Provide where shown on drawings a switch for leak sensing on all containment piping within the building. There shall be a leak sensing switch mounted in leak containment at bottom of riser pipe run and also at all elbows (at the end of each pitched horizontal run) in riser pipe run. Leak sensing switches shall be wired to the fuel oil management control center.

P. Duplex strainer: Provide duplex oil strainer for suction side service. Strainer shall have one piece cast iron body and shall be suitable for pressure to 200 psi. Strainer baskets to be fabricated of brass mesh and to come complete with level wrench handle.

Q. Relief valves: Provide two fuel oil pump relief valves. Each valve to be cast bronze body with brass and bronze internals. Valves to have 300 lb body rating with adjustable range of _____ psi.

R. Day tank level control probe: Provide control probe to operate in conjunction with pump set mounted level control center. Control shall be U.L. approved and suitable for tank pressure to 150 psi with ambient temperatures from 0 to 180 degrees F. Control shall be provided with five switches. Control to be provided as a component of the level control center and shall be Preferred Utilities Mfg. Corp., model PLS-5.

S. Day tank rupture basin alarm switch: Rupture basin shall have an integrally mounted U.L. approved leak alarm switch. Switch shall be installed through the side of day tank rupture basin and all leak alarm locations as shown on the drawings. Switch shall interface with pump control system and shall be Preferred Utilities Mfg. Corp., model RB-S-NY. All components of the above specified pumping and control system shall be the product of Preferred Utilities Mfg. Corp.

2.8 FUEL OIL MANAGEMENT AND LEVEL CONTROL CENTER

A. Provide a fuel oil management control cabinet to monitor and control the fuel oil delivery system in response to the demand. Cabinet shall be completely pre-wired, tested and shipped as an integrated system to insure job site reliability. System shall be custom designed to accomplish the control strategy as outlined. Control strategy shall be microprocessor based and utilize a PLC (Programmable Logic Controller). Relay logic is not acceptable. Cabinet shall be manufactured by nationally recognized trade union personnel. All cabinet mounted devices and construction methods shall be in compliance with UL 508A. The cabinet shall be labeled as complying with UL 508A by an OSHA Nationally Recognized Testing Laboratory (NRTL) such as UL, ETL, or equal. The control cabinet manufacturer shall be inspected quarterly by a NRTL to insure continuous compliance with UL 508A construction requirements. System manufacturer shall have factory employed field
service engineers, specializing in microprocessor based control systems. Fuel oil handling system shall be purchased from one manufacturer to insure single source responsibility and quality assurance.

B. Provide complete control and monitoring of the fuel oil pumps, headers, leak detection and day tank. The cabinet shall contain all transformers, started, breakers, relays, alarms, controllers, level logic, tank gauge and leak monitor and shall perform all functions and contain all instrumentation and devices as hereinafter specified.

C. Cabinet enclosure shall be constructed of a minimum of 14 gauge steel, continuously welded and constructed to NEMA 12 / 13 standards. Doors shall be fully gasketed with a turned edge and piano hinges. Cabinet interior shall be primed and finished in a white gloss, chemical resistant enamel. Cabinet exterior shall be primed and finished in a durable chemical resistant, textured gray enamel, suitable for industrial environments.

D. PLC shall have sufficient I/O to accomplish all necessary control functions. The control strategy shall be burned into an EPROM at the factory, and shall be safeguarded against re-configuration by unauthorized/unqualified personnel. The PLC shall be designed so that it will “fail safe” in the event there is a microprocessor failure.

E. PLC shall provide the right amount of discrete outputs to meet the BMCS specification requirement (refer to “Controls” section). Dry contacts to be interfaced with the BMCS as required. Verify all points to be provided for the BMCS system and coordinate with the electrical contractor.

F. All Cabinet wiring shall be run in NEMA approved covered wire ways, and terminate at a numbered terminal strip to facilitate field connections to remote equipment. Fuel oil pump motor starters shall be 3 phase open frame, 120 volt coil, NEMA sized to match the pump motors. Three pole circuit breakers shall have a 10,000 Ampere interrupting capacity.

G. The tank gauge shall be flush mounted on the cabinet.

H. All switches shall have maintained contacts. Provide a single lamp / alarm test push-button to test the function of all lights and alarm circuits. All cabinet front devices shall be identified by black phenolic labels with engraved white lettering.

I. Sequence of control: The control system shall include all required items to maintain the fuel level in the day tank or header between specified high and low limits, provide for automatic changeover from one pump to the other and operation of standby pump should the level in the day tank or header fall below the low alarm setting of the level control assembly, or
should the flow sensor fail to detect flow when the lead pump is running. Shutdown of the system upon leak detection shall also be provided. All alarms shall be sent to the building BMS system, if applicable. All necessary items required to provide the control sequence outlined above shall be mounted and pre-wired within the cabinet.

J. Cabinet shall consist of but not be limited to the following:

1. Micro processor based Programmable Logic Controller (PLC) for all fuel oil handling system alarms and control functions.
2. Combination Annunciator / Keypad (CAK).
3. Press to test button for all alarms and indicating lights (CAK)
5. Motor circuit breakers.
6. Control circuit transformer.
8. Lead Pump alternator logic for normal cycling and pump failure conditions.
9. Lead pump selector switch, with alternating lead lag. (CAK)
10. Manual reset push-button (CAK)
11. Alarm bell
12. Alarm silence push-button. (CAK)
13. Time elapse recorders to measure running time for each pump.
15. Alarm and annunciation for each leak sensor in the system (indicate separately).
16. Indicating lights as follows:
   a. Power on light
b. Pump running (CAK) and N.O. dry contact

c. Pump failure (CAK) and N.O. dry contact

d. Pump set leak (CAK) and N.O. dry contact

e. Strainer high differential (CAK) and dry contact

f. Containment and piping leak sensing for each tank and pump room, piping system shaft and secondary containment drum (CAK) and dry contact

g. Fire valve closed (CAK) and dry contact for each valve.

h. High level alarm (CAK) and dry contact

i. Low level alarm (CAK) and dry contact

j. Header/day tank full alarm “pressure” (CAK) and dry contact

k. System overpressure alarm

l. Loss of flow

K. All wiring shall be covered by labels of nationally recognized unions.

L. The tank gauge and level control system shall be incorporated into this system. Refer to Fuel Oil Distribution section

2.9 FUEL OIL DAY TANK(S) WITH RUPTURE CONTAINMENT BASIN(S)

A. Provide (X) gallon rectangular daytank(s), (275 gallon maximum of NYC inside building above the lowest floor (one tank max per floor)) constructed of reinforced 12 (10 for NYC) gauge steel, with channel side supports, 1/4" drain, removable gasketed 6" square inspection plate, fuel level gauge, Level control probe, vent cap (shipped loose), and a 2" gasketed manual fill cap as specified on the drawings. Tank interior shall be epoxy coated. Exterior shall be hydrostatically tested for tightness by the contractor who makes the installation before the work is closed in and before the system is operated.

B. The minimum pressure for testing the tank shall be one and one half times the maximum working pressure applicable to the tank but in no case less than twenty-five psi. The hydrostatic pressure shall be maintained until all joints and connections have been visually inspected for
leaks, but in no case for less than one half hour. The tank shall not show any permanent deformation as a result of the test.

C. Tank connections shall include fuel inlet, required vent openings, manual fill, overflow to main tank (if gravity return), engine supply, and engine return. All piped with reinforced, welded pipe adapters. Fuel inlet and returns shall have extended drop tubes to prevent surging in the Daytank.

D. Rupture basin (open top) shall surround tank with (200% capacity in New York City only) capacity of tank specified. (NYC also requires 10 gauge steel same as gauge tank). Provide a rupture basin float switch with alarm and pump shut down functions upon detection of oil in the rupture basin. Rupture basin shall have a factory installed rupture basin switch. Switch shall indicate the occurrence of a tank leak into the rupture basin. Rupture basin switch shall be redundantly sealed against vapors and fluids, be lever float operated and magnetically actuated. Wiring enclosure shall be cast aluminum and NEMA 4 constructed. Rupture basin interior shall be epoxy coated. Exterior shall be finished in oil resistant textured gray enamel.

E. Day Tank Level Control Probe: Tank level control probe arranged to maintain the liquid level in the tank Control shall have four float operated switches rated at 100 watts and shall be factory installed through a single 1 ¼” tapping in the top of the day tank. Four switches to control emergency high level pump shutdown (90% capacity) pump off (80% capacity), pump on (50% capacity), emergency to level secondary pump on an annunciation (40% capacity). Unit shall be suitable for pressure to 150 psi, and shall be entirely of non-ferrous material. Electrical connections shall be made external to the tank in heavy duty cast aluminum explosion proof terminal enclosure. Standard switch settings are normally closed with an empty day tank. Probe shall be model PLS-4-LA.

F. Day tank shall have a factory installed vent line switch to indicate the occurrence of a tank overflow into the vent line. Switch shall be mounted in a tee connection as close to the day tank as possible. Switch shall be redundant sealed against vapors and fluids, be lever float operated and magnetically actuated. Wiring enclosure shall be cast aluminum, explosion proof, NEMA 4, and watertight.

2.10 VERTICAL, STEEL, FUEL-OIL AST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Ace Tank & Equipment Company.
   2. Adamson Global Technology Corporation.
   4. Buffalo Tank Company, Inc.
   5. Cardinal Tank Corp.
   7. Containment Solutions, Inc.
   8. Hall Tank Co.
   11. Palmer Manufacturing & Tank Inc.
   12. Steel Tank & Fabricating Co., Inc.
   13. Watco Tanks, Inc.
   14. We-Mac Manufacturing, Inc.

C. Description: UL 142 and STI F921, double-wall, vertical, steel tank; with primary- and secondary-containment walls and interstitial space.

D. Construction: Fabricated with welded, carbon steel suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and maintained temperature up to 150 deg F.

E. Capacities and Characteristics:
   2. Diameter: <Insert feet>.
3. Length: <Insert feet>.

4. Connection Sizes:
   a. Fill Line: <Insert NPS>.
   b. Vent Line: <Insert NPS>.
   c. Outlet: <Insert NPS>.
   d. Return: <Insert NPS>.
   e. Gage: <Insert NPS>.

5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.

6. Fuel-Oil Grade Number: <Insert number>.

2.11 HORIZONTAL, STEEL, FUEL-OIL AST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Ace Tank & Equipment Company.
   2. Adamson Global Technology Corporation.
   4. Buffalo Tank Company, Inc.
   5. Cardinal Tank Corp.
   7. Containment Solutions, Inc.
8. Hall Tank Co.
11. Palmer Manufacturing & Tank Inc.
12. Safe-T-Tank Corp.
13. Steel Tank & Fabricating Co., Inc.
14. Watco Tanks, Inc.
15. We-Mac Manufacturing, Inc.

C. Description: UL 142 and STI F921, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and interstitial space.

D. Construction: Fabricated with welded, carbon steel; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with maintained temperature up to 150 deg F.

E. Supports: Manufacturer's standard type and number, steel or cast-iron cradles, for field installation.
   1. Number of Supports: <Insert number>.

F. Capacities and Characteristics:
   2. Diameter: <Insert feet>.
   3. Length: <Insert feet>.
   4. Connection Sizes:
      a. Fill Line: <Insert NPS>.
      b. Vent Line: <Insert NPS>.
      c. Outlet: <Insert NPS>.
d. Return: <Insert NPS>.
e. Gage: <Insert NPS>.

5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.

6. Fuel-Oil Grade Number: <Insert number>.

2.12 CONTAINMENT-DIKE, STEEL, FUEL-OIL AST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Areo Power Unitized Fueler Inc.
   2. Buffalo Tank Company, Inc.
   3. Cardinal Tank Corp.
   5.Containment Solutions, Inc.
   6. Hall Tank Co.
   9. Palmer Manufacturing & Tank Inc.
   10. Safe-T-Tank Corp.
   11. Watco Tanks, Inc.
   12. We-Mac Manufacturing, Inc.
C. Description: UL 142 and STI F911, single-wall, horizontal, steel tank; with open or enclosed secondary-containment dike with capacity greater than tank capacity.

D. Construction: Fabricated with welded, carbon steel; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with maintained temperature up to 150 deg F.

E. Capacities and Characteristics:
2. Diameter: <Insert feet>.
3. Length: <Insert feet>.
4. Connection Sizes:
   a. Fill Line: <Insert NPS>.
   b. Vent Line: <Insert NPS>.
   c. Outlet: <Insert NPS>.
   d. Return: <Insert NPS>.
   e. Gage: <Insert NPS>.
5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.
6. Fuel-Oil Grade Number: <Insert number>.

2.13 INSULATED, STEEL, FUEL-OIL AST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Ace Tank & Equipment Company.
2. Adamson Global Technology Corporation.
3. Areo Power Unitized Fueler Inc.
5. Containment Solutions, Inc.
6. ConVault, Inc.
7. Hamilton Tanks.
10. Palmer Manufacturing & Tank Inc.
11. Steel Tank & Fabricating Co., Inc.
12. We-Mac Manufacturing, Inc.

C. Description: UL 142, UL 2085, and STI F941, thermally insulated and fire-resistant, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.

D. Construction: Fabricated with welded, carbon steel and insulation; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

E. Capacities and Characteristics:
2. Diameter: <Insert feet>.
3. Length: <Insert feet>.
4. Connection Sizes:
   a. Fill Line: <Insert NPS>. 
b. Vent Line: <Insert NPS>.
c. Outlet: <Insert NPS>.
d. Return: <Insert NPS>.
e. Gage: <Insert NPS>.

5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.

6. Fuel-Oil Grade Number: <Insert number>.

2.14 CONCRETE-VAULTED, STEEL, FUEL-OIL AST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Cardinal Tank Corp.
   2. ConVault, Inc.
   3. Earthsafe Systems, Inc.
   4. EcoVault, Inc.

C. Description UL 142, UL 2085, and STI F941; thermally insulated, fire-resistant and protected, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.

D. Construction: Fabricated with welded, carbon steel and insulation and encased in concrete that will protect from bullets; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

E. Capacities and Characteristics:
2. Diameter: <Insert feet>.

3. Length: <Insert feet>.

4. Connection Sizes:
   a. Fill Line: <Insert NPS>.
   b. Vent Line: <Insert NPS>.
   c. Outlet: <Insert NPS>.
   d. Return: <Insert NPS>.
   e. Gage: <Insert NPS>.

5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.

6. Fuel-Oil Grade Number: <Insert number>.

2.15 STEEL, FUEL-OIL UST WITH STI-P3

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Ace Tank & Equipment Company.
   2. Adamson Global Technology Corporation.
   5. Containment Solutions, Inc.
6. Hall Tank Co.
7. Hamilton Tanks.
10. Lannon Tank Corporation.
12. Palmer Manufacturing & Tank Inc.
14. Steel Tank & Fabricating Co., Inc.
15. Watco Tanks, Inc.
16. We-Mac Manufacturing, Inc.

C. Description: UL 58 and STI P3, double-wall, horizontal, steel tank; with cathodic protection and electrical isolation.
   1. Containment Method: STI-P3, Type II, with interstitial space.

D. Construction: Fabricated with welded steel; suitable for operation at atmospheric pressure and for storing liquids with specific gravity up to 1.1; fabricated for the following loads:
   1. Depth of Bury: 3 feet from top of tank to finished surface.
   2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.

E. Corrosion-Protection System: Protect tank and factory-installed piping by engineered and installed corrosion-protection system according to STI P3, with means of monitoring cathodic protection.

F. Capacities and Characteristics:
2. Diameter: <Insert feet>.
3. Length: <Insert feet>.
4. Connection Sizes:
   a. Fill Line: <Insert NPS>.
   b. Vent Line: <Insert NPS>.
   c. Outlet: <Insert NPS>.
   d. Return: <Insert NPS>.
   e. Gage: <Insert NPS>.
5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.
6. Fuel-Oil Grade Number: <Insert number>.

2.16 COMPOSITE, STEEL, FUEL-OIL UST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Ace Tank & Equipment Company.
   2. Adamson Global Technology Corporation.

5. Containment Solutions, Inc.

6. Hall Tank Co.

7. Hamilton Tanks.


9. Palmer Manufacturing & Tank Inc.

10. Watco Tanks, Inc.

11. We-Mac Manufacturing, Inc.

C. Description: UL 58, double-wall, horizontal, composite tank; with coating complying with UL 1746 and STI F894.
   1. Containment Method: STI F894, Type II, with interstitial space.

D. Construction: Fabricated with welded steel and factory coating according to UL 1746 and STI F894; suitable for operation at atmospheric pressure and for storing liquids with specific gravity up to 1.1; fabricated for the following loads:
   1. Depth of Bury: 3 feet from top of tank to finished surface.
   2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.

E. Capacities and Characteristics:
   2. Diameter: <Insert feet>.
   3. Length: <Insert feet>.
   4. Connection Sizes:
      a. Fill Line: <Insert NPS>. 
b. Vent Line: <Insert NPS>.

c. Outlet: <Insert NPS>.

d. Return: <Insert NPS>.

e. Gage: <Insert NPS>.

5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.

6. Fuel-Oil Grade Number: <Insert number>.

2.17 JACKETED, STEEL, FUEL-OIL UST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Ace Tank & Equipment Company.
   2. Cardinal Tank Corp.
   3. Clawson Tank Company.
   4. Hamilton Tanks.
   5. Highland Tank & Manufacturing Company, Inc.
   7. Lannon Tank Corporation.
   8. Palmer Manufacturing & Tank Inc.
C. Description: Jacketed, horizontal, steel tank; complying with UL 58, and with plastic or fiberglass jacket and corrosion-protection system according to UL 1746 and STI F922.

D. Construction: Tank fabricated with welded carbon steel, and jacket fabricated with plastic or fiberglass and vacuum-sealed interstitial space; suitable for operation at atmospheric pressure and with integral leak-detection device. Tank fabricated for the following loads:
   1. Depth of Bury: 3 feet from top of tank to finished surface.
   2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.

E. Capacities and Characteristics:
   2. Diameter: <Insert feet>.
   3. Length: <Insert feet>.
   4. Connection Sizes:
      a. Fill Line: <Insert NPS>.
      b. Vent Line: <Insert NPS>.
      c. Outlet: <Insert NPS>.
      d. Return: <Insert NPS>.
      e. Gage: <Insert NPS>.
   5. Manholes:
      a. Number Required: <Insert number>.
      b. Diameter: <Insert inches>.
   6. Fuel-Oil Grade Number: <Insert number>. 
2.18 FRP FUEL-OIL UST

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Containment Solutions, Inc.
   2. Xerxes Corporation

C. Description: Horizontal, FRP UST; UL 1316, double wall, with interstitial space and integral, hydrostatic, leak-detection and monitoring system.

D. Construction: Fabricated with fiberglass-reinforced polyester resins; suitable for operation at atmospheric pressure; fabricated for the following loads:
   1. Depth of Bury: 3 feet from top of tank to finished surface.
   2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 2:1 if hole is fully flooded.

E. Capacities and Characteristics:
   2. Diameter: <Insert feet>.
   3. Length: <Insert feet>.
   4. Connection Sizes:
      a. Fill Line: <Insert NPS>.
      b. Vent Line: <Insert NPS>.
      c. Outlet: <Insert NPS>.
      d. Return: <Insert NPS>.
e. Gage: <Insert NPS>.

5. Manholes:
   a. Number Required: <Insert number>.
   b. Diameter: <Insert inches>.

6. Fuel-Oil Grade Number: <Insert number>.

2.19 SHOP PAINTING OF AST

A. Apply manufacturer’s standard prime coat to exterior steel surface of AST and supports.
B. Prepare exterior steel surface of AST and tank supports.
C. Shop Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3
D. After cleaning, remove dust or residue from cleaned surfaces.
E. If surface develops rust before prime coat is applied, repeat surface preparation.
F. Apply manufacturer’s standard prime coat to shop-cleaned, dry surface same day as surface preparation.
G. Apply manufacturer’s standard two-component, epoxy finish coats.

2.20 FUEL-OIL AST ACCESSORIES

A. Tank Manholes: 22-inch minimum diameter; bolted, flanged, and gasketed; centered on top of tank.
B. Tank Manholes: 22-inch minimum diameter; bolted, flanged, and gasketed; on top and at side of tank.
C. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
D. Threaded pipe connection fittings on top or sides of tank as indicated, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
E. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.

F. Lifting Lugs: For handling and installation.

G. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.

H. Ladders: Carbon-steel ladder outside tank, anchored to top and side wall. Comply with requirements in Division 05 Section "Metal Fabrications" for exterior steel ladder.
   1. Cage: Include welded steel cage around ladders for tanks 10 feet high or higher.

I. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

J. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

2.21 FUEL-OIL UST ACCESSORIES

A. Tank Manholes: 22-inch minimum diameter; bolted, flanged, and gasketed, with extension collar; for access to inside of tank.

B. Steel Tank Masonry Supports: Two 6-by-6-by-3/8-inch steel angles, 72 inches long, located longitudinally on tank on each side of manholes and continuously welded in place.

C. Threaded pipe connection fittings on top of tank for fill, supply, return, vent, sounding, and gaging, in locations and of sizes indicated. Include cast-iron plugs for shipping.

D. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.

E. Lifting Lugs: For handling and installation.

F. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom. Include reinforcement of tank at bottom of ladder.

G. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
H. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

I. Containment Sumps: Fiberglass with sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include sump entry boots for pipe penetrations through sidewalls.

J. Sump Entry Boots: Two-part pipe fitting for field assembly and of size required to fit over pipe. Include gaskets shaped to fit sump sidewall, sleeves, seals, and clamps as required for liquid-tight pipe penetrations.

K. Anchor Straps: Storage tank manufacturer's standard anchoring system, with straps, strap-insulating material, cables and turnbuckles, of strength at least one and one-half times maximum uplift force of empty tank without backfill in place.

L. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total weight of 3 oz./sq. yd.

M. Overfill Prevention Valves: Factory fabricated or shop or field assembled from manufacturer's standard components. Include drop tube, cap, fill nozzle adaptor, check valve mechanism or other devices, and vent if required to restrict flow at 95 percent of tank capacity and to provide complete shutoff of filling at 98 percent of tank capacity.

2.22 FUEL-OIL STORAGE TANK PIPING SPECIALTIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. EBW, Inc.

2. Environ Products, Inc.


4. OPW.

5. Preferred Utilities Manufacturing Corporation.

6. Universal Valve Company.
B. Fitting Materials: Cast iron, malleable iron, brass, or corrosion-resistant metal; suitable for fuel-oil service.

C. Spill-Containment Fill Boxes: Flush mounting, with drainage feature to drain oil into tank, threaded fill-pipe connection, and wrench operation.

D. Supply and Sounding Drop Tubes: Fuel-oil supply piping or fitting, inside tank, terminating 6 inches above bottom of tank, and with end cut at a 45-degree angle.

E. Pipe Adapters and Extensions: Compatible with piping and fittings.

F. Suction Strainers and Check Valves: Bronze or corrosion-resistant metal components.

G. Foot Valves and Anti-siphon Valves: Poppet-type, bronze or corrosion-resistant metal components.

H. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

I. Metal Manholes: 22-inch- minimum diameter frame and cover. Furnish manhole units of adequate size for access to fittings if size is not indicated.

J. Monitoring Well Caps: Locking pipe plug and manhole.

2.23 SUBMERSIBLE FUEL-OIL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. FE Petro, Inc.
   2. Red Jacket Pumps; a division of Veeder-Root.

C. Description: Comply with UL 79, UL 87, and UL 343.
1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

2. Impeller: Turbine.

3. Housing and Volute: Cast iron.


5. Seals: Mechanical.


7. Suspension Piping: Telescoping to accommodate tank diameter and depth of bury.


9. Pressure Relief: Built in.

10. Discharge Check Valve: Built in.

11. Drive: Direct, close coupled.

D. Controls: Pump controller panel complying with UL 353 and UL 508C and with interlock and terminals for connections to fuel-oil-burning equipment diesel-driven fire pumps diesel-driven emergency generators and diesel-fuel-oil dispenser.

1. Run pumps to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F.

2. Run pumps on seven-day schedule.

3. Stage pumps on pressure at a common supply manifold.

4. Alternate pumps to equalize run time.

5. Alarm motor failure.


7. Deenergize and alarm pump locked rotor condition.

8. Alarm open circuit, high and low voltage.
9. Indicating lights for power on, run, and off normal conditions.

10. Interface with automatic control system is specified in Division 23 Section "Instrumentation and Control for HVAC" to control and indicate the following:
   a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
   b. Operating status.
   c. Alarm off-normal status.

E. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

F. Capacities and Characteristics:
   1. Number of Stages: <Insert number>.
   2. Capacity: <Insert gph>.
   3. Discharge Pressure: <Insert psig>.
   4. Outlet Size: <Insert NPS>.
   5. Motor Speed: <Insert rpm>.
   7. Electrical Characteristics:
      a. Volts: 120 208 240 <Insert value>.
      b. Phase: Single Three.
c. Hertz: 60.
d. Full-Load Amperes: <Insert value>.
e. Minimum Circuit Ampacity: <Insert value>.
f. Maximum Overcurrent Protection: <Insert amperage.>

2.24 SIMPLEX FUEL-OIL TRANSFER PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Fuel-Oil Transfer Pumps:
   a. DESMI INC./Rotan Pumps.
   b. DeLaval
   c. Combustion Technology
   d. Haight Pumps; Division of Baker Mfg.
   e. Preferred Utilities Manufacturing Corporation.
   f. Suntec Industries Incorporated.
   g. Tuthill Corporation; Tuthill Pump Div.
   h. Viking Pump Inc.; a Unit of IDEX Corporation.
   i. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.

2. NRTL-Listed, Fuel-Oil Transfer Pumps:
   a. Tuthill Corporation; Tuthill Pump Div.
   b. Viking Pump Inc.; a Unit of IDEX Corporation.
   c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
C. Description: Comply with UL 343, and HI M109.
   1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   2. Type: Positive-displacement, rotary type.
   3. Impeller: Steel gear with crescent
   4. Housing: Cast-iron foot mounted.
   7. Seals: Mechanical.
   9. Pressure Relief: Built in.
  10. Discharge Check Valve: Built in.

D. Drive: direct, close coupled

E. Controls:
   1. Run pump to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F
   2. Run pump on seven-day schedule.
   3. Alarm motor failure.
   5. Deenergize and alarm pump locked rotor condition.
   6. Alarm open circuit, high and low voltage.
   7. Indicating lights for power on, run, and off normal conditions.
   8. Interface with automatic control system is specified in Division 23 Section "Instrumentation and Control for HVAC" to control and indicate the following:
a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.

b. Operating status.

c. Alarm off-normal status.

F. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

G. Capacities and Characteristics:

1. Number of Stages: <Insert number>.

2. Capacity: <Insert gph>.

3. Inlet Vacuum: <Insert inches Hg>.

4. Discharge Pressure: <Insert psig>.

5. Inlet and Outlet Size: <Insert NPS>.


8. Electrical Characteristics:

a. Volts: 120 208 240 <Insert value>.

b. Phase: Single Three.

c. Hertz: 60.

d. Full-Load Amperes: <Insert value>.
2.25 DUPLEX TRIPLEX FUEL-OIL TRANSFER PUMP SETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Alyan Pump Company.
   2. Hydronic Modules Corporation.
   4. Smith-Koch, Inc.
   5. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.

C. Description: Comply with HI M109.
   1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
   2. Type: Positive-displacement, rotary type.
   3. Impeller: Steel gear with crescent
   4. Housing: Cast-iron foot mounted.
   7. Seals: Mechanical.
   9. Pressure Relief: Built in.
   10. Discharge Check Valve: Built in.
D. Drive: direct close coupled

E. Controls:
1. Run pumps to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F
2. Run pumps on seven-day schedule.
3. Stage pumps on pressure at a common supply manifold.
4. Alternate pumps to equalize run time.
5. Alarm motor failure.
7. Deenergize and alarm pump locked rotor condition.
8. Alarm open circuit, high and low voltage.
9. Indicating lights for power on, run, and off normal conditions.
10. Interface with automatic control system is specified in Division 23 Section "Instrumentation and Control for HVAC" to control and indicate the following:
   a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
   b. Operating status.
   c. Alarm off-normal status.

F. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
G. Piping Furnished with Pumps: Steel with ferrous fittings and threaded or welded joints.

H. Strainers Furnished with Pumps: Duplex, basket type with corrosion-resistant-metal-screen baskets.

I. Capacities and Characteristics:
   1. Number of Stages: Insert number>.
   3. Inlet Vacuum: <Insert inches Hg>.
   4. Discharge Pressure: <Insert psig>.
   5. Inlet and Outlet Size: <Insert NPS>.
   8. Electrical Characteristics (Pump Set):
      a. Volts: 120 208 240 <Insert value>.
      b. Phase: Single Three.
      c. Hertz: 60.
      d. Full-Load Amperes: <Insert value>.
      e. Minimum Circuit Ampacity: <Insert value>.
      f. Maximum Overcurrent Protection: <Insert amperage>.

2.26 FUEL MAINTENANCE SYSTEM

   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

   B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      1. Fuel Technologies, International, LLC.
C. Description: Factory fabricated and wired fuel maintenance system for fuel-oil filtration; with
enclosure, filter, fuel-oil pump, and controls; FMG approved, listed, and labeled by an NRTL
acceptable to authorities having jurisdiction.
1. Enclosure: NEMA 250, Type 3R, painted steel containing pumps, filters, accessories,
   and controls. Hinged door on the front of enclosure.

2. Pump: Comply with HI M109, steel-gear-with-crescent, positive-displacement, direct-
coupled, rotary-type.

3. Materials: Cast-iron housing; bronze bearings; steel shaft; mechanical seals; and built-
in, pressure relief bypass valve.

4. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure
type, and efficiency requirements for motors specified in Division 23 Section "Common
Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so
driven load will not require motor to operate in service factor range above 1.0.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for
electrical devices and connections specified in Division 26 Sections.

5. Piping: Steel with malleable-iron fittings and threaded joints or wrought-steel fittings
   and welded joints.

   a. Stage 1: 100-mesh strainer.
   b. Stage 2: Centrifuge to separate particulates and water from oil.
   c. Stage 3: Coalescing water and particulate filter.
   d. Stage 4: 30-micron particulate removal.
   e. Stage 5: 10-micron particulate removal.
   f. Stage 6: Minimum 99.5 percent water removal with see-through bowl and
      water-sensor probe.
   g. Stage 7: 1.5micron particulate removal.
7. Multiple-Tank Manifolds:
   a. Manifold fabricated of Schedule 80, black steel pipe and threaded nipples for four tanks.
   b. Solenoid valves for supply and return piping to each tank.
   c. Strainers for each tank supply connection.

8. Programmable Logic Controller:
   a. Alarm on maximum 15-in. Hg vacuum at pump suction indicating plugged filter.
   b. Alarm on high water level in filter.
   c. Alarm leak in enclosure.
   d. Touch screen; with minimum 2-line, 20-character, backlit, LCD display.
   e. Controller strip heater with thermostat.

9. Interface with automatic control system is specified in Division 23 Section "Instrumentation and Control for HVAC" to control and indicate the following:
   a. Start/stop system when required by schedule.
   b. Operating status.
   c. Alarm off-normal status.

D. Capacities and Characteristics:

2. Maximum Suction Lift: 15 feet

3. Inlet and Outlet Size: <Insert NPS>.


5. Electrical Characteristics (Pump Set):
   a. Volts: 120 208 240 <Insert value>.
b. Phase: Single Three.

c. Hertz: 60.

d. Full-Load Amperes: <Insert value>.

e. Minimum Circuit Ampacity: <Insert value>.

f. Maximum Overcurrent Protection: <Insert amperage>.

2.27 LIQUID-LEVEL GAGE SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:


2. Clawson Tank Company.

3. EBW, Inc.


5. INCON, Inc.

6. King Engineering Corp.


8. Pneumercator Inc.


10. Rochester Gauges, Inc.

11. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.


13. Venture Measurement Company, LLC.
C. Description: Calibrated, liquid-level gage system complying with UL 1238 with probes or other sensors and remote annunciator panel.

D. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.

E. Controls: Electrical, operating on 120 V ac.

2.28 LEAK-DETECTION AND MONITORING SYSTEM

A. Cable and Sensor System: Comply with UL 1238.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   
   b. Containment Solutions, Inc.
   
   c. EBW, Inc.
   
   d. Gems Sensors Inc.
   
   e. Highland Tank & Manufacturing Company, Inc.
   
   f. INCON, Inc.
   
   g. In-Situ, Inc.
   
   h. MSA; Instrument Div.
   
   i. Perma-Pipe, Inc.
   
   j. Pneumercator Inc.
   
   k. Raychem Corp; Tyco Electronics Corporation.
l. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.
m. Veeder-Root; a Danaher Corporation Company.

3. Calibrated, leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.

4. Include fittings and devices required for testing.

5. Controls: Electrical, operating on 120-V ac.

6. Calibrated, liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel.


8. Controls: Electrical, operating on 120-V ac.

B. Hydrostatic System: Comply with UL 1238.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings comparable product by one of the following:
   b. Containment Solutions, Inc.
   c. EBW, Inc.
   d. Gems Sensors Inc.
   e. Highland Tank & Manufacturing Company, Inc.
   f. INCON, Inc.
   g. In-Situ, Inc.
3. Calibrated, leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.

4. Include fittings and devices required for testing.

5. Controls: Electrical, operating on 120-V ac.

6. Calibrated, liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel.


8. Controls: Electrical, operating on 120-V ac.

2.29 FUEL OIL

A. Fuel Oil: ASTM D 396, Grade No. 1 No. 2.

B. Diesel Fuel Oil: ASTM D 975, Grade Low Sulfur No. 1-D, special-purpose No. 2-D, general-purpose, high volatility.

2.30 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

2.31 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.

3. Pressure Plates: Carbon steel

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.32 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube and with OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
   1. Finish: Polished chrome-plated

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated
E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.33 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

2.34 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

2.35 CONCRETE MANHOLES

A. Precast Concrete Manhole Sections: ASTM C 478, base and concentric-cone sections with integral ladder or steps.

B. Cast-Iron Frame and Cover: Heavy-duty, water-resistant, cast-iron manhole frame, gasket, and bolted cover; 24-inch diameter, inside opening dimension; 8-inch frame riser height.

2.36 SOURCE QUALITY CONTROL

AKF
A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, according to ASME and the following:
   1. Vertical, Vertical or Horizontal, Horizontal, Single-Wall Steel ASTs: UL 142.
   2. Vertical, Vertical or Horizontal, Horizontal, Double-Wall Steel ASTs: UL 142, STI F921, and STI R931.
   3. Horizontal, Containment-Dike, Steel ASTs: UL 142 and STI F911.
   4. Horizontal, Concrete-Vaulted Concrete-Vaulted and Insulated Insulated, Steel ASTs: UL 142 and UL 2085.
   5. Horizontal, Steel USTs with the STI-P3 Corrosion-Protection System: UL 58 and STI P3.
   7. FRP USTs: UL 1316.

B. Affix standards organization’s code stamp.

2.37 DEFINITIONS

A. AST: Aboveground storage tank.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

E. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.

F. FRP: Glass-fiber-reinforced plastic.

G. UST: Underground storage tank.
2.38 PERFORMANCE REQUIREMENTS

A. Maximum Operating-Pressure Ratings: 3-psig fuel-oil supply pressure at oil-fired appliances.

B. Delegated Design: Design restraint and anchors for fuel-oil piping, ASTs, and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Seismic Performance: Factory-installed support attachments for AST shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.39 QUALIFICATIONS FOR DOUBLE WALL PIPING SYSTEMS

D. A. The prefabricated piping manufacturer shall have a minimum of 15 years experience in the engineering and manufacturing of the cataloged piping system. The manufacturer shall provide 10 projects that have been active for a minimum of 10 years. The names and phone numbers of the installing contractor and consulting engineer shall also be provided for reference.

2.40 PIPING APPLICATIONS

A. Use flanges, unions, transition, and special fittings and valves with pressure ratings same as or higher than system pressure rating in above ground and containment sump applications, unless otherwise indicated.

B. Above ground fuel oil piping and vent piping: Use the following:

   1. Fuel oil piping above the lowest floor in building shall be enclosed in shaft constructed of 4 inch concrete or masonry having a 4 inch clearance from all pipe or pipe covering. A drain pipe shall be installed at the base of shafts. The drain pipe shall lead to open sight drain or to an open sump. Pipe shafts shall not be penetrated by or contain other piping or ducts. Where it is necessary to make horizontal offsets in the pipe and pipe shafts such piping shall be double wall (pipe within a pipe) all welded.
construction with steel material, further enclosed in a 2-hour fire rated enclosure. The double wall construction with the leak protection system shall be used also for the fuel oil drain line. Provisions for pipe expansion shall be made without the use of expansion joints.

C. 2 inch NPS and smaller: Steel pipe, steel welded fittings and welded joints. If screwed fittings are required they shall be externally welded.

D. 2-1/2 inch and above: Steel pipe, steel welded fittings and welded joints.

E. Above ground fuel oil piping containment conduit: Schedule 10 steel, welded joints.

F. Diesel Engine and Natural Gas Engine Lubricating Oil System:
   1. Material shall be in accordance with ASTM A 53, Grade B seamless.
   2. Wall thickness shall be:
   3. To 2 inch: Schedule 80 with threaded ends at connections to equipment and strainers, or Schedule 40 with socket weld ends
   4. 2-1/2 inch and larger: Schedule 40, butt weld ends only.

2.41 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
      a. Single-Wall Tanks: Minimum 3 psig and maximum 5 psig.
b. Double-Wall Tanks:

1) Inner Tanks: Minimum 3 psig and maximum 5 psig.

2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.

c. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.

d. Maintain the test pressure for one hour.

2. Piping: Minimum hydrostatic test-pressures measured at highest point in system:

a. Fuel-Oil Distribution Piping: Minimum: Less than 100 psig operating pressure, test hydrostatically to 150 psig. Over 100 psig operating pressure, test hydrostatically to 1-1/2 times operating pressure but never exceed test pressure for minimum 4 hours.

b. Fuel-Oil, Double-Containment Piping:

1) Carrier Pipe: Minimum: Less than 100 psig operating pressure, test hydrostatically to 150 psig. Over 100 psig operating pressure, test hydrostatically to 1-1/2 times operating pressure but never exceed test pressure for minimum 4 hours.

2) Containment Conduit: Minimum 5 psig for minimum 60 minutes.

c. Suction Piping: Minimum 20-in. Hg for minimum 30 minutes.

d. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.

3. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.

4. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than five different depths while filling tank and checking against gage indication.
5. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.

6. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.

7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

8. Bleed air from fuel-oil piping using manual air vents.

D. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.42 OUTDOOR PIPING SCHEDULE

A. Underground fuel-oil piping shall be one of the following. Size indicated is carrier-pipe size.
   1. Flexible, double-containment piping.
   2. Rigid, double-containment piping.

B. Underground fuel-oil-tank fill and vent piping shall be one of the following:
   1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints. Coat pipe and fittings with protective coating for steel piping.
   2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints. Coat pipe and fittings with protective coating for steel piping.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

D. Aboveground fuel-oil piping shall be one of the following:
   1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
   2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

2.43 INDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping shall be one of the following:
1. NPS 1/2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints
2. NPS 5/8 to NPS 2: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints
3. NPS 2-1/2 and Larger: Steel pipe, steel fittings, and welded or flanged joints
4. Steel pipe with malleable-iron fittings and threaded joints.
5. Steel pipe with wrought-steel fittings and welded joints.

2.44 ABOVEGROUND MANUAL FUEL-OIL SHUTOFF VALVE SCHEDULE

B. Distribution piping valves for pipe NPS 2 and smaller shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.

C. Distribution piping valves for pipe NPS 2-1/2 and larger shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze, lubricated plug valve.

D. Valves in branch piping for single appliance shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.

2.45 ENVIRONMENTAL CLEANUP

A. Provide environmental cleanup for existing and new fuel oil installation as required for this project in accordance with all authorities having jurisdiction.

END OF SECTION 231113
HYDRONIC PIPING
SECTION 232113 - HYDRONIC PIPING

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. High temperature hot water piping
2. Medium temperature hot water piping
3. Hot-water heating piping.
4. Chilled-water piping.
5. Dual-temperature heating and cooling water piping.
6. Condenser-water piping.
7. Glycol cooling-water piping.
8. Boiler feed water
9. Diesel engine jacket cooling
10. Makeup-water piping.
11. Condensate-drain piping.
15. Air control devices
16. Strainers
17. Pump suction diffusers
18. Vacuum Breakers

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
1. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

E. Steel Pipe Welding:
   1. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Welders shall be qualified for all required pipe sizes, material, wall thickness, and position in accordance with the American Society of Mechanical Engineering (ASME) Section IX, boiler and pressure Vessel Code
   3. Copies of the certified welder qualification reports shall be maintained by the responsible welding agency and the company performing the welding, and shall be submitted to the owner and/or Inspector upon request.
   4. All defective welds shall be chipped out and repaired at no cost to the Owner, based on procedure to be specified at the time.
   5. The contractor shall bear the cost of re-inspection of the repaired welds and the inspection of two (2) additional welds, as selected by the owner, for each failed weld.
   6. Field Procedures:
      a. Clean pipe free from rust, scale and oxide.
      b. Bevel pipe on each end per acceptable procedures.
      c. Contractor is responsible for preparation of pipe in accordance with ASME B 31.1, Chapter V and for visual inspection during the welding operation and for all required welding examinations with certified welding inspector(s), in
accordance with ANSI/AWS B.1.10-86 or latest issue section 3.1, 3.1.1, 3.1.2, and 3.1.3.

F. Copper Tube Brazing
   1. Qualify process and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications”
   2. Brazers shall be qualified for all required tube sizes, material, wall thickness, and position in accordance with the American Society of Mechanical Engineering (ASME), Section IX, boiler and Pressure Vessel Code.
   3. Brazing qualification testing shall be performed by an agency/laboratory certified by ASME.
   4. Copies of the certified brazer qualification reports shall be maintained by the responsible brazing agency and the company performing the brazing, and shall be submitted to the owner and/or Inspector.
   5. All defective brazements shall be chipped out and repaired at no cost to the Owner, based on procedures to be specified at the time.
   6. The contractor shall bear the cost of re-inspection of the repaired brazements and the inspection of two (2) additional brazements, as selected by the owner, for each failed brazement.
   7. Field Procedures:
      1) Clean tubing free from surface oxidation on the O.D.
      2) Ream all tubes and remove burrs created by the cutting operation, on each end per acceptable procedures.
      3) Contractor is responsible for preparation of tubes and for visual inspection during the brazing operation in accordance with all applicable ASME, ANSI and AWS standards.

G. MEDIUM and HIGH TEMPERATURE WATER PIPE TESTING

   1. All welds shall be full fusion and penetration, and be subjected to radiographic testing as follows.
      a. Perform radiographic examination of butt welds in piping accordance with ASME requirements.
      b. above 150 PSIG – All
      c. Testing shall be performed by an independent lab hired by this contractor, submit results to owner.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of the following:
   1. Submit a schedule indicating the following:
      a. System, Service, Operating temperature, Operating pressure, Pipe material, Fittings, Methods of joining, Gaskets, Specialties, Test pressure, Flange gaskets, Fittings, Unions, Dielectric unions, Suction diffusers, Ring spacers and test blanks.
   2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   3. Strainers
   4. Air control devices.
   6. Hydronic specialties.

B. Shop Drawings: Detail, at 3/8 inch scale piping layout with fittings, valves and equipment, use single line for pipe sizes 3 inches and smaller, and double line for pipe sizes 4 inches and greater. Fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops
   1. Minimum 3/8 inch scale double line layout and sections where required or coordination drawings.

C. Welding certificates.

D. Qualification Data: For Installer.

E. Field quality-control test reports, Written reports of tests specified. Include the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS
REFER TO RESPECTIVE PARAGRAPHS FOR APPROVED MANUFACTURERS FOR EACH TYPE OF PIPING PRODUCT.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type K
B. Annealed-Temper Copper Tubing: ASTM B 88, Type K
C. Wrought-Copper Fittings: ASME B16.22.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. S. P. Fittings; a division of Star Pipe Products.
D. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

2. End Connections: Butt welding.
3. Facings: Raised face.

H. materials and wall thicknesses as pipe in which they are installed.

2.4 FIBERGLASS PIPE AND FITTINGS

A. RTRP: ASTM D 2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.

B. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.

C. Flanges: ASTM D 4024. Full-face gaskets suitable for the service, minimum 1/8-inch thick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.

D. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
c. For high temperature water – Klinger C4500
d. For medium temperature water - Klinger C4500
e. For chilled water systems – Klinger suitable for glycol use.
f. For hot water – Klinger C4500
g. For joints of dissimilar metals, provide isolating gaskets, sleeves and washers between flanges, bolts and nuts. Gaskets shall be similar to Dupont Teflon

B. Flange Bolts, Studs, Nuts and Washers:

1. Bolts and studs shall be chrome-molybdenum bolt stud in accordance with ASTM A 193 grade B7 with full-length threads in accordance ANSI B 31.1. Length shall be sufficient to project beyond nuts three complete threads when joint is made.

2. Nuts shall be carbon-steel in accordance with ASTM A 194 Grade 2H. Nuts shall be hexagon heavy series type. Threads shall the same as for bolts.

3. Washers shall be flat, plain, stamped, in accordance with ANSI/ASME B18.22.1.

C. Ring Spacers and Test Blanks:

1. Provide between flanges where shown on drawing or where necessary to isolate equipment from the piping system, in accordance with B3.1.1, Chapter VI, section 137.2.4. Ring spacers to be replaced by test blanks during hydrostatic testing and/or during chemical cleaning for equipment isolation.

2. Size and rating to match companion flanges.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

1. Comply with Section II, Part C of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

G. Crimp or press fittings shall not be used.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing company
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   d. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   b. Central Plastics Company.
c.  Watts Regulator Co.; a division of Watts Water Technologies, Inc.

3.  Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E.  Dielectric-Flange Kits:
1.  Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a.  Advance Products & Systems, Inc.
   b.  Calpico, Inc.
   c.  Central Plastics Company.
   d.  Pipeline Seal and Insulator, Inc.

2.  Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3.  Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F.  Dielectric Couplings:
1.  Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a.  Calpico, Inc.
   b.  Lochinvar Corporation.

2.  Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G.  Dielectric Nipples:
1.  Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a.  Perfection Corporation; a subsidiary of American Meter Company.
   b.  Precision Plumbing Products, Inc.
   c.  Sioux Chief Manufacturing Company, Inc.
   d.  Victaulic Company of America.

2.  Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, and 300-psig minimum working pressure at 225 deg F.
2.7 VALVES

A. Gate, Globe, Check, Ball, safety relief and balancing Valves:. Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

2.8 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.
2. Bell & Gossett Domestic Pump; a division of ITT Industries.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 240 deg F.

D. Expansion Tanks:

1. General:
a. Provide as shown on the drawings, a pressurization and air elimination system to accommodate the expanded water generated by the increase in temperature in the water system and to control the increase in pressure at all critical components in the system to the maximum allowable for those components.

b. The pressurization and air elimination system shall ensure that all air in the system shall be eliminated. The only air in the system shall be the permanent sealed in air cushion contained in the pressurization controller component of the system, a diaphragm type expansion tank, pre-charged to the minimum operating pressure at the location indicated on the drawing.

c. All free air originally contained in the system, and all entrained air bubbles carried by system water shall be eliminated at all points in the piping system where the capability of water to hold air in solution is lowest (the point of lowest solubility), and as indicated on the drawings. The air separating and elimination component shall separate entrained air from flowing system water by the creation of a vortex which will allow free air to rise in the center, the point of lowest velocity, to an air elimination valve.

2. Diaphragm or Bladder -Type Expansion Tanks:
   a. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Diaphragm or bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
   c. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
   d. Orientation: Vertical.
   e. Orientation: Horizontal.
   f. Size and capacity as scheduled on the drawings.
   g. Features:
      1) Integral structural steel supports
      2) Base for vertical tanks.
      3) Cradle for horizontal tanks.
      4) Gasketed handhole.
      5) Gasketed manhole.
6) All tappings for gauge glass, instrumentation, drain, fill and connections to system: Refer to detail on the drawings.
7) Pre-charged with air to pressure scheduled on drawings.

E. Tangential-Type Air Separators:
   1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
   2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
   3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
   5. Size: Match system flow capacity.

F. In-Line Air Separators
   1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
   3. Maximum Operating Temperature: Up to 300 deg F.

G. Air Purgers:
   1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
   3. Maximum Operating Temperature: 250 deg F.

2.9 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

   1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
B. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

C. The HVAC Contractor shall hire the services of the building water treatment contractor and provide all required labor and materials. Provide temporary metering and mixing devices as required. The HVAC contractor shall obtain and provide all requirements from the Owner/water treatment vendor.

2.10 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Chilled Water, Condenser Water and Hot Water Systems of Steel Construction:

   a. Working pressure: To 250 psig, non-shock.
   
   1) Sizes 1/4 inch to 2 inch: ANSI 250 lb. Class.
      
      a) Connections: Threaded.
      
      b) Body: Cast iron, ASTM A126, Class B. With machined seat for screen retention. Galvanized as required to match connecting piping.
      
      c) Cap: Bronze, gasketed.
      
      d) Screen: 20 mesh. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.
      
      e) Blowoff outlet: With female NPT tapping.
      
      f) Mueller model No. 11 MFCB.
   
   2) Sizes 2-1/2 inch to 24 inch: Class 250.
      
      a) Connections: Flanged.
b) Body: Cast iron, ASTM A126, Class B. With machined seat for screen retention. Galvanized as required to match connecting piping.

c) Cover flange: Cast iron, ASTM A126, Class B. With machined seat for screen retention. With female tapped NPT blowoff connection. With EPDM O-ring seal.

d) Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.

e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.

f) Magnets: Provide magnets for strainers. All 8 inch and larger. At each pump suction. With continuous magnetic field around entire circumference of screen. With removable cast Alnico No. 5 channel magnets with acceptable baskets constructed of magnetic alloy. Secured with stainless steel retaining lugs and threaded rods.

g) Blowoff outlet: With female NPT tapping.

h) Mueller model No. 752.

b. Working pressure: To 285 psig at 100 deg F ANSI Class 150 and 740 psig at 100 deg F ANSI Class 300, non-shock:

1) Sizes 1/2 inch to 12 inch:

   a) Connections: Flanged or butt welded to match piping system.

   b) Body: Carbon steel, ASTM A216, Grade WCB. With machined seat for screen retention.

d) Screen: Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.

e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.

f) Magnets: Provide magnets for strainers. All 8 inch and larger. At each pump suction. With continuous magnetic field around entire circumference of screen. With removable cast Alnico No. 5 channel magnets with acceptable baskets constructed of magnetic alloy. Secured with stainless steel retaining lugs and threaded rods.

g) Blowoff outlet: With female NPT tapping.

h) Mueller model No. 761 for ANSI Class 150. Mueller model No. 762 for ANSI Class 300.

2) Sizes 14 inch to 24 inch:

a) Connections: Flanged or butt welded to match piping system.

b) Body: Carbon steel, ASTM A216, Grade WCB. With machined seat for screen retention.


d) Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.
e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.

f) Magnets: Provide magnets for strainers. All 8 inch and larger. At each pump suction. With continuous magnetic field around entire circumference of screen. With removable cast Alnico No. 5 channel magnets with acceptable baskets constructed of magnetic alloy. Secured with stainless steel retaining lugs and threaded rods.

g) Blowoff outlet: With female NPT tapping.

h) Mueller model No. 781 for ANSI Class 150.

i) Mueller model No. 782 for ANSI Class 300.

2. Chilled Water, Condenser Water and Hot Water and Glycol Systems of Copper Construction:

   a. Working pressure: To 250 psig, non-chock.

      1) Sizes 1/4 inch to 2 inch: Class 250

         a) Connections: Threaded.


         d) Screen: 20 mesh. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 time inlet area.

         e) Blowoff outlet: With female NPT tapping.

         f) Mueller model No. 352M.

   b. Working pressure to 225 psig Class 150; to 400 psig Class 300:
1) Sizes 2-1/2 inch to 12 inch:
   a) Connections: Flanged.
   c) Cover: Material to match body. With machined seat for screen retention.
   d) Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.
   e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.
   f) Blowoff outlet: With female NPT tapping.
   g) Mueller model No. 851 or 851M for Class 150.
   h) Mueller model. No. 852 for Class 300.

3. Medium Temperature and High Temperature Water Systems:
   a. Working pressure: To 150 psig at 565 deg F; ANSI Class 150 and 300 psig at 835 deg F; ANSI Class 300.
      1) Sizes 1/2 inch to 12 inch:
         a) Connections: Flanged or but welded to match piping system.
         b) Body: Carbon steel, ASTM A216, Grade WCB. With machined seat for screen retention.
         c) Cover: Carbon steel, ASTM 216, Grade WCB. With machined seat for screen retention. With female tapped NPT blowoff connection. With non-asbestos gasket.
d) Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.

e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.

f) Magnets: Provide magnets for strainers. All 8 inch and larger. At each pump suction. With continuous magnetic field around entire circumference of screen. With removable cast Alnico No. 5 channel magnets with acceptable baskets constructed of magnetic alloy. Secured with stainless steel retaining lugs and threaded rods.

g) Blowoff outlet: With female NPT tapping.

h) Mueller model No. 761 for ANSI Class 150.

i) Mueller model No. 762 for ANSI Class 300.

2) Sizes 14 inch to 24 inch:

a) Connections: Flanged or butt welded to match piping system.

b) Body: Carbon steel, ASTM 216, Grade WCB. With machined seat for screen retention.


d) Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.

e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.
f) Magnets: Provide magnets for strainers. All 8 inch and larger. At each pump suction. With continuous magnetic field around entire circumference of screen. With removable cast Alnico No. 5 channel magnets with acceptable baskets constructed of magnetic alloy. Secured with stainless steel retaining lugs and threaded rods.

g) Blowoff outlet: With female NPT tapping.

h) Mueller model No. 781 for ANSI Class 150.

i) Mueller model No. 782 for ANSI Class 300.

B. Basket Strainers:
1. Chilled Water and Condenser Water Systems of Steel Construction:
   a. Working pressure: To 250 psig, non-shock.
      1) Sizes 1-1/4 inch to 16 inch: ANSI 150 lb. Class.
         a) Connections: Flanged.
         b) Body: Ductile iron, ASTM 395. With tapped and plugged drain connections.
         c) Cover: A 515-70 plate. With non-asbestos gasket.
         d) Basket to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area. Closed bottom. With handles.
         e) Basket 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area. Closed bottom. With handles.
         f) Mueller model No. 166 DI.

   b. Working pressure to 285 psig at 100 deg F; ANSI Class 150 and 740 psig at 100 deg F, ANSI Class 300; non-shock:
      1) Sizes 3/4 inch to 16 inch:
a) Connections: Flanged.

b) Body: Carbon steel, ASTM 126, Grade WCB. With tapped and plugged drain connection. With machined and gasket seat.

c) Cover flange: A515-70 plate. With non-asbestos gasket.

d) Basket to 4 inch: 1/16 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 6.6 times inlet area. Closed bottom. With handles.

e) Basket 5 inch to 12 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 6.6 times inlet area. Closed bottom. With handles.

f) Basket 14 inch and larger: 3/16 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 6.6 times inlet area. Closed bottom. With handles.

g) Mueller model No. 196CS for ANSI Class 300.

2. Chilled Water and Condenser Water Systems of Copper Construction:

   a. Working pressure to 225 psig ANSI Class 150; to 400 psig ANSI Class 300:

      1) Sizes 2 inch to 12 inch:

         a) Connections: Flanged.


         c) Cover: Bronze ASTM B62 (85-5-5-5). With non-asbestos gasket.

         d) Basket to 4 inch: 1/16 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area. Closed bottom. With handles.
e) Basket 5 inch to 12 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area. Closed bottom. With handles.

f) Mueller model No. 165B for ANSI Class 150.

g) Mueller model No. 166 for ANSI Class 300.

C. Pump Suction Diffuser:

1. Working Pressure:

   a. Sizes 2 inch to 12 inch: 110 psig at 300 deg F to 200 psig at 105 deg F, non-shock, wog.

   b. Sizes 14 inch and larger: 150 psig at 150 deg F, non-shock, wog.

   c. Connections:

      1) To 2 inch: Threaded.

      2) 2-1/2 inch and larger: Flanged.

   d. Body:

      1) Cast iron, ASTM 126, Class B.

      2) With pad and female NPT tapping for base support.

   e. Cover:

      1) Cast iron, ASTM A126, Class B.

      2) For sizes to 8 inch x 8 inch with quick opening ductile iron knobs and EPDM O-ring seal.

      3) For sizes 10 inch x 8 inch and larger: Bolted with EPDM O-ring seal.


   f. Inlet vanes:
1) 304 stainless steel.

g. Orifice cylinder:
   1) 304 stainless steel.

h. Start up screen:
   1) 20 mesh.
   2) 304 stainless steel.

i. Magnetic separator.

2. Working pressure:
   a. Sizes to 12 inch: 565 psig at 300 deg F to 640 psig at 100 deg F, non-shock, wog.

   b. Connections:
      1) To 2 inch: Threaded.
      2) 2-1/2 inch to 12 inch: Flanged.

   c. Body:
      1) Ductile iron, ASTM A536.
      2) With pad and female NPT tapping for base support.

   d. Cover:
      1) Ductile iron, ASTM A536.
      2) Bolted with EPDM O-ring seal.

   e. Inlet vanes:
      1) 304 stainless steel.
f. Orifice cylinder:
   1) 304 stainless steel.

g. Start up screen:
   1) 20 mesh.
   2) 304 stainless steel.

h. Magnetic separator.

D. Vacuum Breakers

1. For service to 300 psig wsp, similar to Sarco VB 12:
   a. Size: 1/2 inch.
   b. Features:
      1) All internals renewable without disturbing piping.
   c. Construction:
      1) Cap: Stainless steel, Type 303.
      2) Valve: VB 12 stainless steel, Type 303.
      3) Valve seat: VB 12 stainless steel, Type 303.
      4) Body: VB 12 stainless steel, Type 303.
      5) Gasket: VB 12 stainless steel, Type 304.
      6) Connections:
         a) System: 1/2 inch screwed NPT.
         b) Air inlet: 1/8 inch screwed NPT.

E. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
2.11 PIPING APPLICATIONS

A. High Temperature Hot Water System, 350 deg F to 450 deg F supply temperature:
   1. Material shall be steel in accordance with ASTM A 106 or A 53, Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 16 inch: 0.375 inch wall thickness, butt weld ends only.
      d. 18 to 24 inch: 0.500 inch wall thickness, butt weld ends only.

B. Medium Temperature Hot Water System, 220 deg F to 350 deg F supply temperature:
   1. Material shall be steel in accordance with ASTM A 106 or A 53, Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch and larger: 0.375 inch wall thickness, Grade B, butt weld ends only.

C. Low Temperature Water System, IN EXCESS of 100 psig up to 300 PSIG, except as noted and 40 to 220 deg F supply temperature for hot water, condenser water, chilled water, primary and secondary brine, dual temperature water and glycol systems:
   1. Material shall be steel in accordance with ASTM A 53, seamless Grades A or B.
   2. Wall thickness shall be:
Hydronic Piping

3. 4 inch and smaller up to 300 PSIG and 100 deg F or 150 PSIG and 250 deg F, Type K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

4. No threaded joints are allowed in glycol systems.

D. Low Temperature Water System, NOT IN EXCESS of 100 psig and -20 to 220 deg F supply temperature for hot water heating, condenser water, chilled water, primary and secondary brine and glycol systems:

1. Material shall be steel in accordance with ASTM A 53, seamless, Grades A or B.

2. Wall thickness shall be:

   a. To 2 inch: Schedule 40 with threaded ends or Schedule 40 with socket weld ends.
   b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
   c. 12 inch and larger: 0.375 inch wall thickness up to 250 psig, butt weld ends only.
   d. 12 inch and larger: 0.500 inch wall thickness greater than 250 psig and up to 400 psig, butt weld ends only.

   3. 4 inch and smaller Type K, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

   4. No threaded joints are allowed in glycol systems.
E. Boiler Feed Water with water temperature 220 deg F and greater:

1. Material shall be steel in accordance with ASTM A 106 or A 53, Grade B seamless.

2. Wall thickness shall be:
   a. To 2 inch: Schedule 40 with socket weld ends.
   b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.

3. 12 inch and larger: 0.375 inch wall thickness, butt weld ends only.

F. Boiler Feed Water with water temperature less than 220 deg F:

1. Material shall be steel in accordance with ASTM A 53, seamless, Grades A or B.

2. Wall thickness shall be:
   a. To 2 inch: Schedule 80 with threaded ends or Schedule 40 with socket weld ends.
   b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
   c. 12 inch to 16 inch: 0.375 inch wall thickness, butt weld ends only.

G. Boiler Blowdown:

1. Material shall be steel in accordance with ASTM A 106 or A 53, Grade B seamless.

2. Wall thickness shall be:
   a. To 2 inch: Schedule 80 with socket weld ends only.
   b. 2-1/2 inch to 10 inch: Schedule 80, butt weld ends only.

H. Water Treatment Chemical Feed Piping and Sampling Piping:

I. Instrument Piping:
1. As specified for system piping to which connected

J. Diesel Engine Jacket Cooling Water System: As specified for condenser water.

1. For systems with pressure less than 100 psig:

   a. Material shall be in accordance with ASTM A 53, seamless, Grades A or B.

   b. Wall thickness shall be:

      1) To 2 inch: Schedule 80 with threaded ends or Schedule 40 with socket weld ends.

      2) 2 inch to 10 inch: Schedule 40, butt weld ends only.

      3) 12 inch and larger: 0.375 inch wall thickness, butt weld ends only.

2. For systems with pressure 100 psig up to 300 PSIG:

   a. Material shall be in accordance with ASTM A 53, seamless, Grades A or B.

   b. Wall thickness shall be:

      1) To 2 inch: Schedule 80 with threaded ends or Schedule 40 with socket weld ends.

      2) 2 inch to 10 inch: Schedule 40, butt weld ends only.

      3) 12 inch and larger: 0.375 inch wall thickness, butt weld ends only.

K. Compressed Air System for Diesel Engine and Natural Gas Engine Starting:

1. Material shall be in accordance with ASTM A 53, Grade B seamless.

2. Wall thickness shall be:

   a. To 2 inch: Schedule 40 with socket weld ends only.
b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.

L. Refrigerant Pumpdown Unit Cooling Water:
1. Material shall match connecting plumbing work:
   a. To 2-1/2 inch: Copper, Type L, ASTM B88.
   b. 3 inch and larger: Galvanized steel in accordance with ASTM A 53, Grade B, Schedule 40, threaded ends.

M. Makeup-water piping installed aboveground shall be either of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

N. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

O. Condensate-Drain Piping: Type , L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

P. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

Q. Air-Vent Piping:
1. Inlet: Same as service where installed
2. Outlet: Same as service where installed.

R. Safety-Valve-Inlet and Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

S. Provide dielectric fittings for connection of dissimilar metals. Use of bronze valves is not acceptable as a dielectric.
2.12 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install spring loaded check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at heat exchangers hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

2.13 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping." Systems less than 100 psig, hydrostatically test to 150 psig.
5. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.
HYDRONIC PUMPS
SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

2. Close-coupled, end-suction centrifugal pumps.
4. Separately coupled, vertical, in-line centrifugal pumps.
5. Separately coupled, base-mounted, end-suction centrifugal pumps.
7. Separately coupled, vertical-mounted, double-suction centrifugal pumps.
8. Separately coupled, vertical-mounted, turbine centrifugal pumps.
9. Automatic condensate pump units.
10. High temperature water pumps
11. Sealess self priming pumps
12. Modification to existing pumps

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.


C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

D. Factory quality control and test data

E. Warranty

PART 2 - PRODUCTS

A.

B. APPROVED MANUFACTURERS

C. GENERAL PUMP REQUIREMENTS

D. Pump Units: factory assembled and tested, package pump and motor, single-stage except as noted, and suitable for scheduled conditions of service.

E. Pump and motor capacities: Minimum as scheduled, suitable for parallel operation. Each motor shall be non-overloading and shall operate over entire head capacity range of pump without exceeding nameplate horsepower rating.
F. Pump characteristics: Pump curve shall rise continuously from maximum capacity to shut off. Shut off head shall be approximately 10 percent greater than design head. Operation shall be at or near peak efficiency. Pumps shall be capable of operating at 25 percent beyond design capacity without exceeding breakoff point. Impeller diameter shall not exceed minimum published diameter plus 90 percent of the difference between published maximum and minimum impeller diameters.

G. Casing: of material specified, with ANSI flanges on inlet and outlet, plugged drain and vent connections, and replaceable bronze wearing rings.

H. Impeller: Centrifugal type except as noted, totally enclosed, non-over loading, one-piece impeller of material specified, with entire rotating assembly statically, dynamically and hydraulically balanced.

I. Motor: High efficiency, ODP type conforming to specification section “MOTORS”.

J. Abrasive separator: Except as noted, provide seal finish piping connections with stainless steel abrasive separator.

K. Bearings: except as noted, grease lubricated or oil lubricated with oiled, moisture and dust resistant housing, minimum 20,000 hour B-10 life (100,000 hour average life) under scheduled conditions of service.

L. Pumps shall be tested and designed to withstand 1-1/2 times the specified working pressure.

M. Performance curve derived from certified laboratory tests only.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

B. Bell & Gossett; Div. of ITT Industries.

C. Grundfos Pumps Corporation.
D. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.

E. MEPCO (Marshall Engineered Products Co.).

F. PACO Pumps.

G. Weinman; Div. of Crane Pumps & Systems

H. Patterson

I. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F. Pump Construction:

J. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange union end connections.

K. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

L. Pump Shaft: Steel, with copper-alloy shaft sleeve

M. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.

N. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

O. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

   a. Bell & Gossett; Div. of ITT Industries.

   b. Buffalo Pumps, Inc.; an Ampco Pittsburgh Co.
c. PACO Pumps.
d. Weinman; Div. of Crane Pumps & Systems.
e. Patterson

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump 175-psig minimum working pressure and a continuous water temperature of 225 deg F

C. Pump Construction:

a. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gauge tappings at inlet and outlet, and threaded companion-flange flanged connections.
b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
c. Pump Shaft: Steel, with copper-alloy shaft sleeve
d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
e. Pump Bearings: Oil lubricated; bronze-journal or thrust type.
f. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 SEPARATELY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS

A. Available Manufacturers:

a. Bell & Gossett; Div. of ITT Industries.
b. Grundfos Pumps Corporation.
c. PACO Pumps.
d. Patterson

B. Description: Factory-assembled and tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
   a. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

D. Shaft Coupling: Molded rubber insert with interlocking spider Interlocking frame with interconnecting springs capable of absorbing vibration.

E. Motor: Single speed, with oil-lubricated sleeve bearings, unless otherwise indicated; and resiliently mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.6 SEPARATELY COUPLED, VERTICAL, IN-LINE CENTRIFUGAL PUMPS

A. Available Manufacturers:
   a. Bell & Gossett; Div. of ITT Industries.
b. PACO Pumps.

c. Weinman; Div. of Crane Pumps & Systems.

d. Patterson

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

a. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.

b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

c. Pump Shaft: Steel, with copper-alloy shaft sleeve.

d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.

e. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

D. Shaft Coupling: Axially split spacer coupling.

E. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.7 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

a. Bell & Gossett; Div. of ITT Industries.
b. Buffalo Pumps, Inc.; an Ampco Pittsburgh Co.

c. PACO Pumps.

d. Weinman; Div. of Crane Pumps & Systems.

e. Patterson

B. Description: Base-mounted, centrifugal, flexible-coupled, end-suction, single-stage, bronze-fitted, back-pull-out, radially split case design; with a front mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.

1. Casing: Close grained cast iron, with flanged piping connections, drain plug at low point of volute, threaded gage tappings at inlet and outlet connections, and integral feet or other means on volute to support weight of casing and attached piping. Casing shall allow removal and replacement of impeller without disconnecting piping.

2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, keyed to shaft, and secured by locking cap screw.

3. SHAFT: carbon steel

4. SHAFT SLEEVE: Bronze replaceable to completely cover the wetted area under the seal.

5. SHAFT SEAL:
   a. Single inside mounted
   b. Internally flushed mechanical type
   c. End face rubber bellows
   d. Stainless steel springs
   e. Brass or stainless steel heads
   f. Babbitt filled carbon rotating washer
   g. Tungsten carbide rotating seat
h. Bronze or stainless steel glands
i. Water flush design to provide flush across the face of the mechanical seal.
j. With bypass line from pump discharge through cyclone separator to flush gland. Cyclone separator shall be similar to John Crane Kynar
k. Suitable for continuous operation at 225°F (107°C) continuous.
l. Provide type as follows:
   1) For suction pressures up to 150 psig.: similar to John Crane Type 1.
   2) For suction pressures 150 psig or greater: balanced construction seals similar to John Crane type 1B
m. Working pressure at 225°F (107°C) continuous duty.
   1) 125 PSIG (860 kPa)
   2) 175 PSIG (1204 kPa)
   3) 200 PSIG (1376 kPa)
   4) 250 PSIG (2064 kPa)
   5) 300 PSIG (2064 kPa)

n. Base Plate: Cast iron, rolled steel or fabricated structural steel with raised lip, drain tappings, grout holes and anchor bolt holes.
o. Coupling:
   1) Flexible type.
   2) Center drop out design with flange and sleeve section that can be disassembled and removed without removing pump or motor.
   3) Capable of absorbing torsional vibration.
   4) Provide an EPDM coupler sleeve for pumps with variable frequency drive motor controllers. Coupling shall be Woods spacer type.
5) Provide steel coupling guard of removable type securely fastened to the pump base, compliant with ANSI B15.1 and OSHA 1910.219.

p. Nozzle velocity: Maximum 24 ft per second at duty point.

q. Motor: Secured to mounting frame, with adjustable alignment.

r. Testing: Each pump shall be factory tested per Hydraulic Institute Standards.

s. Cleaning and Painting; Clean each pump thoroughly and paint with one coat of primer and two coats of high grade machinery enamel prior to shipment.

C. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.8 SEPARATELY COUPLED, BASE-Mounted, DOUBLE-Suction CENTRIFUGAL PUMPS

A. Manufacturers:

1. Bell & Gossett; Div. of ITT Industries.

2. Buffalo Pumps, Inc.; an Ampco Pittsburgh Co.

3. PACO Pumps.

4. Weinman; Div. of Crane Pumps & Systems.

5. Patterson

2. Description: Base-mounted, centrifugal, flexible-coupled, double-suction, single-stage, bronze-fitted, axially split case design.

B. Casing:

a. Material:

1) Ductile iron to 400 PSIG working pressure

b. Axially split with suction and discharge flanges on a common centerline in both the vertical and horizontal planes.
c. Mounting feet cast integral with the lower half of the casing

d. Suction and discharge Flanges:

e. 125 PSIG ASA Standard
f. 250 PSIG ASA Standard
g. 300 PSIG ASA Standard

2. Threaded gage tappings at suction and discharge connections.

3. Threaded drain plug at low point of volute

4. Vent valve at high point of volute

5. Upper half of casing shall be removable without disturbing suction and discharge piping.

C. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, enclosed, type double suction, and keyed to shaft.

D. Wear Rings: Casing and impeller wear rings shall be renewable, dissimilar bronze of hardness to protect against polling. The rings shall be installed with an anti-rotation device, and designed to prevent leakage across the ring bit.

E. Shaft: Carbon steel, designed to operate under load with minimum deflection. Stuffing box housing and bearing brackets shall be made of cast iron, separate from the casing and mounted in cylindrical bits in the end of the casing.

F. Shaft sleeve: renewable, unhardened 416 stainless steel.

G. Shaft seal:

1. Mechanical seal
   
a. Single inside mounted
   
b. Internally flushed mechanical type.
   
c. End face rubber bellows
d. Stainless steel springs

e. Brass or stainless steel heads

f. Babbitt filled carbon rotating washer

g. Tungsten carbide rotating seat.

h. Bronze or stainless steel glands

i. Water flush design to provide flush across face of the mechanical seal.

j. With bypass line from pump discharge through cyclone separator to flush gland. Cyclone separator shall be similar to John Crane Kynar.

k. Suitable for continuous operation at 225°F (107°C)

l. Mounted directly on the shaft and located so that seal lubrication is positioned to flow directly over the seal faces. Arrangement shall ensure that seal leakage cannot enter the bearing housing. Seals shall be suitable for conditions stated. Piping shall be burnished to provide seal lubrication and shall be mounted on the upper half of the casing.

m. Provide type as follows:
   1) For suction pressures up to 150 PSIG.: similar to John Crane Type 1.
   2) For suction pressures 150 PSIG or greater: balance construction seals similar to John Crane Type 1B.

H. Trim: Trim, shaft nut, and stuffing box bushing shall be bronze.

I. Working pressure at 225°F (107°C) continuous duty.
   a. 125 PSIG (860 kPa)
   b. 175 PSIG (1204 kPa)
   c. 200 PSIG (1376 kPa)
   d. 250 PSIG (1720 kPa)
Hydronic Pumps

e. 300 PSIG (2064 kPa)

J. Base Plate: Cast iron, rolled steel or fabricated structural steel welded with raised lip, drain tappings, grout holes, and under bolt holes.

K. Coupling:
   a. Flexible type
   b. Center drop out design with flange and sleeve that can be disassembled or removed without removing pump or motor.
   c. Capable of absorbing torsional vibration.
   d. Provide an FPDM coupler sleeve for pumps with Variable Frequency Drive Motor Controllers. Coupling shall be Woods spacer type.
   e. Provide steel coupling guard of removable type securely fastened to the pump base, compliant with ANSI B15.1 and OSHA 1910.219.

L. Nozzle velocity: Maximum 22 ft per second at duty point.

M. Bearings shall be grease-lubricated ball type, single row inboard selected to carry radial thrust only, and double row outboard selected to carry radial and thrust loads. Bearing housings shall be maintained in positive alignment by a 360 degree male-female fit. The housings shall provide a fit for the inboard bearing that allows freedom for thermal expansion while the outward bearing shall be clamped in place to take all thrust loads and keep the rotating element in its proper axial location. Plugged openings for adding new grease and draining old grease shall be provided.

N. Motor: Secured to mounting frame, with adjustable alignment.

O. Testing: Each ramp shall be factory tested per Hydraulic Institute Standards.

P. Cleaning and Painting: Clean each pump thoroughly and paint with one coat of primer and two coats high grade machinery enamel prior to shipment.

Q. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
2.9 SEPARATELY COUPLED, VERTICAL-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
   a. Bell & Gossett; Div. of ITT Industries.
   b. PACO Pumps.
   c. Patterson

B. Description: Base-mounted, centrifugal, flexible-coupled, double-suction, single-stage, bronze-fitted, vertically split case design;

   1. Casing
      a. Material
         1) Ductile iron to 400 PSIG working pressure
      b. Suction and Discharge Flanges:
         1) 125 PSIG ASA Standard
         2) 250 PSIG ASA Standard
         3) 300 PSIG ASA Standard
      c. Threaded gage tappings at suction and discharge connections.
      d. Threaded drain plug at low point of volute.
      e. Vent valve at high point of volute.

   2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, double suction, mounted between bearings, and keyed to shaft.
3. Wear rings: Casing and impeller wear rings shall be renewable, dissimilar bronze of hardness to protect against galling. The rings shall be installed with an anti-rotational device, and designed to prevent leakage across the ring bit.

4. Shaft: Carbon steel, designed to operate under load with minimum deflection. Stuffing box housing and bearing brackets shall be made of cast iron, separate from the casing and mounted in cylindrical fits in the end of the casing.

5. Shaft sleeve: renewable, unhardened 416 stainless steel.

6. Shaft seal:
   a. Mechanical seal
      1) Single inside mounted
      2) Internally flushed mechanical type.
      3) End face rubber bellows.
      4) Stainless steel springs.
      5) Brass or stainless steel heads.
      6) Babbit filled carbon rotating washer.
      7) Tungsten carbide rotating seat.
      8) Bronze or stainless steel glands
      9) Water flush design to provide flush across the face of the mechanical seal
      10) With, bypass line from pump discharge through cyclone separator to flush gland. Cyclone separator shall be similar to John Crane Kynar
      11) Suitable for continuous operation at 225°F (107°C)
      12) Mounted directly on the shaft and located so that seal lubrication is positioned to flow directly over the seal faces. Arrangement shall ensure that real leakage cannot enter the bearing housings. The seals shall be capable of being serviced without disconnecting the pump from the piping and shall be suitable for conditions stated. Piping shall be
furnished to provide seal lubrication and shall be mounted on the upper half of the casing.

13) Provide type as follows:
   a) For suction pressures up to 150 PSIG similar to John Crane Type 1.
   b) For suction pressures 150 PSIG or greater: balanced construction seals similar to John Crane type 1B

14) 125 PSIG (860 kPa)
15) 175 PSIG (1204 kPa)
16) 200 PSIG (1376 kPa)
17) 250 PSIG (1720 kPa)
300 PSIG (2064 kPa)

b. Base Plate: Cast iron, rolled steel or fabricated structured steel, welded with raised lip, drain tappings, grout holes, and/or bolt holes.

c. Coupling:
   1) Flexible type
   2) Center drop out design with flange and sleeve that can be disassembled and removed without removing pump or motor.
   3) Capable of absorbing torsional vibration.
   4) Provide an EPDM coupler sleeve for pumps with variable frequency drive motor controllers. Coupling shall be Woods spacer type.
   5) Provide steel coupling guard of removable type securely fastened to the pump base, compliant with ANSI B15.1 and OSHA 1910.219.

d. Nozzle velocity: Maximum 22 ft per second at duty point.
e. Bearings: Regreasable, camlock, ball bearing type with provision for purging or flashing through the bearing surface and capable of being inspected by removing the bearing covers.

f. Motor: Secured to mounting frame, with adjustable alignment.

g. Testing: Each pump shall be factory tested per Hydraulic Institute Standards.

h. Cleaning and Painting: Clean each pump thoroughly and paint with one coat of primer and two coats high grade machinery enamel prior to shipment.

2.10 SEPARATELY COUPLED, VERTICAL-MOUNTED, TURBINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Bell & Gossett; Div. of ITT Industries.

2. PACO Pumps.

3. Weinman; Div. of Crane Pumps & Systems.

B. Description: Base mounted vertical configuration, single or multi-stage suitable for installation in a sump approximately 10 feet in depth or greater.

C. Bowl Assembly

1. Intermediate bowls, and discharge adapter.


   b. Intermediate bowls:

      1) Identical design for interchangeability

      2) With ultra glass lined waterways for maximum efficiency and protection.

   c. Connection: discharge adapter to connect bowls to column.
D. Impellers.

1. Material: B836 bronze
2. Balanced and filler for optimum performance and minimum vibration.
3. Securely fastened to the bowl shaft with taper locks of 416 SS.
4. Adjustable by means of a top shaft adjusting nut.

E. Suction Bowl.

1. Material: close grained cast iron, ASTM designation A-48, Class 30
2. Bearings
   a. Non soluble grease packed type.
   b. Material: Bronze
   c. Bronze round collar to protect the bearings from abrasives.
3. Bearing housing.
   a. Sufficient openings at the bottom for easy removal of the bearings.

F. Wear rings: Pumps 6’ and larger shall be fitted with replaceable wear rings of bronze, SAE 660, in the suction bowl and intermediate bowls. Wear rings shall have the minimum practical clearance to the mating cylindrical surface of the impeller to provide adequate sealing independent of vertical positioning of the impellers.

G. Bowl Shaft: The bowl shaft shall be constructed from ASTM A582 type 416 stainless steel. It shall be precision turned, ground and polished and shall be supported by water lubricated SAE660 bronze bearings or optional fluted rubber bearings.

H. Column Assembly:

1. Pump speeds: up to 2200 RPM shall have intermediate column lengths and lineshaft bearing spacing not to exceed 10 feet.
2. Column pipe: The column pipe shall be sized as per AWWA - E101. Inside diameter of the pipe shall be such that the head losses shall not be over 5 feet per 100 feet of pipe. The column sections shall be flanged on both ends. The flanges shall have machined male and female registers to ensure proper alignment after assembly.

3. Lineshaft: of ample size to operate the pump without distortion or vibration. Shaft shall be furnished in interchangeable sections not over ten feet in length and shall be coupled with extra strong threaded steel couplings machined from solid bar steel. Lineshaft shall be 416 SS.

4. Bronze centering spiders of the drop in type shall be furnished for shaft stabilization at each column pipe coupling. Bearings shall be fluted rubber retained in the spider by a shoulder on each end of the bearing.

I. Discharge Head Assembly: shall be of the high profile type and be a suitable base of high grade cast iron, ASTM A48-30 or fabricated steel. It shall be provided for mounting the motor with a discharge elbow having an above ground flanged discharge outlet for 12" standard pipe. The design shall have sufficient capacity to carry the combined weight of the column assembly. The design shall allow the top shaft to couple above the stuffing box. The head shall have a 1/2" NPT connection for a pressure gauge.

J. Shaft Seal:

1. The stuffing box shall be cast iron and shall contain a maximum of five rings of packing. It shall have a pressure relief connection. The packing gland shall be extra heavy bronze split type secured in place with bronze or stainless steel studs and nuts. The bearing shall be SAE660 bronze. A rubber slinger shall be secured to the shaft above the packing gland.

2. Packing: up to 50 psig suction pressure provide ring type, graphitized, plastic similar to John Crane type 1065. From 50-100 psig provide combination rings, graphitized, non-asbestos material, and babbit foil arranged in accordance with manufacturer’s recommendations, similar to John Crane type 101M.

K. Suction Pipe and Strainer: The suction pipe shall have a minimum inside diameter and weight equal in that of the discharge column pipe. A suitable cone strainer of galvanized steel shall be provided having a free area of at least five times the flow area.
L. Hollow Shaft Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to discharge head. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.11 VERTICAL MULTI STAGE PUMPS

A. Description: Base mounted centrifugal, flexible coupled, in-line configuration, multi-stage, flexible coupled, vertical design.

B. Casing: Close grained cast iron with flanged pipe connection, threaded gage tappings at inlet and outlet with integral cast pedestal support feet to support the weights of the pump.
   Impeller: 416 stainless steel secured directly to the pump shaft with an inline.

C. Shaft: 416 stainless steel

D. Diffuser chambers: 416 stainless steel

E. Outer discharge sleeve: 416 stainless steel

F. Impeller seal rings: 416 stainless steel

G. Seal ring retainer: 416 stainless steel

H. Motor stool: cast iron

I. Coupling: cast iron

J. Intermediate and lower shaft bearings: Tungsten carbide and ceramic.

K. Coupling guard: stainless steel, compliant with O.S.H.A. Standards.

L. Shaft seal: internally lubricated, self flashing mechanical type

M. Testing: Each pump shall be factory tested per hydraulic institute standards.

N. Cleaning and Painting: Clean each pump thoroughly and paint with one coat of primer and two coats of high grade machinery enamel prior to shipment.

O. Working pressure at 225°F (107°C) continuous duty:
   a. 125 PSIG (860 Kpa)
b. 175 PSIG (1204 Kpa)
c. 200 PSIG (1376 Kpa)
d. 250 PSIG (1720 Kpa)
e. 300 PSIG (2064 Kpa)

2.12 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:
   b. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
   c. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch minimum, electrical power cord with plug.

2.13 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.
   1. Provide system side shut-off valve for isolation

2.14 HIGH TEMPERATURE WATER PUMPS

A. Description: Base mounted, centrifugal, flexible-coupled, end suction, vertical center line discharge, foot mounted casing, single stage, back-pull-out, radially split case, baked frame and cover, quick release bolt bags, designed to ANSI. B73.1 standards.
   1. Casing:
a. Ductile iron  
b. Cast steel  
c. With flanged piping connections, drain plug at low point of volute, threaded gage toppings at inlet and outlet connections, and integral cast pedestal support belt on volute to support weighs of casing and attached piping. Casing shall be constructed to allow back pullout disassembly without disturbing suction or discharge piping.

2. Impeller: 316 stainless steel, statically and dynamically balanced, enclosed type, overhung, single suction, keyed to shaft and secured by a locking cap screw.

3. Shaft: 316 stainless steel, sized for 0.0002 inch maximum deflection.


5. Shaft seal:  
   a. Mechanical, suitable for continuous duty at stated conditions  
   b. Similar to Crane, Balanced Type, TY-1B.

6. Casing cover: 316 stainless steel

7. Gland: 316 stainless steel

8. Rabbeted Fit: To afford positive alignment between back removal element and universal casing, with continuous gasket to revert leakage and protect rabbeted fit.

9. Thrust bearing: Double row to minimize and play with axial adjustment of cartridge to maintain impeller clearance.

10. Frame: Water cooled with 316 stainless steel deflector w/oil lip seal to protect bearing from contamination.


12. Base plate: Cast iron, rolled steel or fabricated structural steel with raised lip, drain tappings, grout holes and anchor bolt hole.
13. Couplings:
   a. Flexible type.
   b. Center drop out design with flange on sleeve section that can be disassembled and removed without removing pump or motor.
   c. Capable of absorbing torsional vibration.
   d. Provide an EPDM coupler sleeve for pumps with variable frequency drive motor controller. Coupling shall be Woods, spacer type.
   e. Provide steel coupling guard of removable type securely fastened to the pump base, compliant with ANSI B15.1 and OSHA 1910.219.

14. Nozzle velocity: Maximum 24 ft per second at duty point.

15. Testing: Each pump shall be factory tested per Hydraulic Institute Standards.

16. Cleaning and Painting: Clean each pump thoroughly and paint with one coat of primer and two coats of high quality of machinery enamel prior to shipment.

17. Specifications and schedule based on Gould Pumps, Inc.

2.15 SEALESS, SELF-PRIMING PUMPS

A. Description: Base mounted, positive displacement, flexible coupled, single stage, vertical suction and discharge, sealless, self-priming. The pumps shall be constructed to combine the pumps fluid to a channel formed by the outer surface of the flexible liner and the inner surface of the pump body block are mechanical action and moving parts are on the inside of the flexible lines.

1. Casing: Polypropylene
2. Flexible Liner: Buna-N rubber for continuous duty to 185°F (85°C).
3. Rotor: Phenolic
4. Pedestal: Cast iron
5. Base: Polypropylene

6. Bearings
   a. Rotor bearings protected within the phenolic motor with a plug on one side and a spring loaded phenolic bearing guard on the other which rides on lapped surface of the bearing sleeve.
   b. Permanently sealed.
   c. External type

7. Discharge pressure up to 45 PSIG.

8. Testing: Each pump shall be factory tested per Hydraulic Institute Standards.

9. Cleaning and Painting: Clean each pump thoroughly and paint with one coat of primer and two coats of high grade machinery enamel prior to shipment.

10. Specifications and schedule based on Vanton Flexiliner.

2.16 MODIFICATION OF EXISTING PUMPS

A. The purpose of these modifications is to modify the conditions of service and performance to those pumps as indicated on the drawings.

B. The contractor is directed to use the original pump manufacturer for the purchase of all parts, alignment work and startup.

C. The work on the pumps shall include but not be limited to the following:
   1. Remove existing motor and replace with new high efficiency motor compatible for use with a VFD.
   2. Provide a new rotating assembly including but not limited to the following:
      a. Impeller.
      b. Shaft.
      c. Wear rings.
d. Mechanical seals.

e. Bearings.

f. Shaft sleeves.

3. Provide a VFD for each pump motor.

4. Install new coupling.

5. Modify baseplate to accept new motor.

6. Install new coupling guard.

D. All work shall be conducted and completed in accordance with the original pump manufacturer's standards and tolerances for the new conditions of service.

END OF SECTION 23 2123
STEAM AND CONDENSATE HEATING PIPING
SECTION 232213 - STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following for LP and HP steam and condensate piping:
   1. Pipe and fittings.
   2. Strainers.
   3. Flash tanks.
   4. Condensate cooler / dilution tank
   5. Steam separators
   7. Pressure-reducing valves.
   8. Steam traps.
   9. Thermostatic air vents and vacuum breakers.
   10. Steam and condensate meters.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify processes and operators according to the following:
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1

E. Steel Pipe Welding:
1. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”

2. Welders shall be qualified for all required pipe sizes, material, wall thickness, and position in accordance with the American Society of Mechanical Engineering (ASME) Section IX, boiler and pressure vessel Code.

3. Welder qualification testing shall be performed by an independent inspection agency listed with the Department of Buildings Agency having jurisdiction for testing that is by radiography. The inspector shall have a minimum radiography qualification of level II in accordance with the American Society for Non-Destructive Testing, 3200 Riverside Drive, Columbus, Ohio 43221. Recommended Practice, Document No. SNT-TC-1A-1980.

4. Copies of the certified welder qualification reports shall be maintained by the responsible welding agency and the company performing the welding, and shall be submitted to the owner and/or Inspector upon request.

5. All defective welds shall be chipped out and repaired at no cost to the Owner, based on procedure to be specified at the time.

6. The contractor shall bear the cost of reinspection of the repaired welds and the inspection of two (2) additional welds, as selected by the owner, for each failed weld.

7. Field Procedures:
   a. Clean pipe free from rust, scale and oxide.
   b. Bevel pipe on each end per acceptable procedures.
   c. Contractor is responsible for preparation of pipe in accordance with ASME B 31.1, Chapter V and for visual inspection during the welding operation and for all required welding examinations with certified welding inspector(s), in accordance with ANSI/AWS B.1.10-86 or latest issue section 3.1, 3.1.1, 3.1.2, and 3.1.3.

8. All welds shall be full fusion and penetration, and be subjected to radiographic testing as follows.
   a. Perform radiographic examination of butt welds in high pressure steam piping and condensate in accordance with NYC Code. Testing shall be performed by an independent lab hired by this contractor, submit results to owner.
   b. Below 90 PSIG – none
   c. 90 PSIG to 150 PSIG – 10 percent at random
   d. above 150 PSIG – All
   e. Testing shall be performed by an independent lab hired by this contractor, submit results to owner.
1.3  FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of the following:

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

D. Factory quality control and test reports

E. Warranty

PART 2 - PRODUCTS

2.1  APPROVED MANUFACTURERS

A. For approved manufacturers refer to respective paragraph of each piping product.

2.2  STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping application article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.
F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

I. Stainless-Steel Bellows, Flexible Connectors:
   2. End Connections: Threaded or flanged to match equipment connected.
   5. Maximum Operating Temperature: 250 deg F.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
      c. For high pressure steam and condensate – Garlock, Style 9800 only
      d. For low pressure steam and condensate - Klinger C4430
      e. For joints of dissimilar metals, provide isolating gaskets, sleeves and washers between flanges, bolts and nuts. Gaskets shall be similar to Dupont Teflon.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Central Plastics Company.
      d. Watts Water Technologies, Inc.
      e. Zurn Plumbing Products Group.
   2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Central Plastics Company.
      c. Watts Water Technologies, Inc.
   2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure as required to suit system pressures.

2.5 STRAINERS

A. Y-Pattern Strainers:

1. Low pressure steam, low pressure condensate and pumped condensate systems of steel construction 15 psig and below:
   a. Working pressure: To 250 psig wsp @ 406°F. Sizes 1/4 inch to 2 inches: ANSI 250 lb Class:
      1) Connections: Threaded.
      2) Body:
         a) Cast iron, ASTM A 126, Class B.
         b) With machined seat for screen retention.
         c) Galvanized as required to match connecting piping.
      3) Cover: Cast iron gasketed.
      4) Screen:
         a) 3/64 inch perforations.
         b) 304 stainless steel, ASTM 240.
         c) Free area not less than 2.5 times inlet area.
Steam and Condensate Heating Piping

5) Blowoff outlet: With female MPT tapping.
6) Mueller Model No. 11 BC.

b. Working pressure: For sizes 2-1/2 inches to 12 inches: To 250 psig wsp @ 450°F. For sizes 14 inches to 24 inches: To 200 psig wsp @ 406°F.

1) Connections: Flanged.
2) Body:
   a) Cast iron, ASTM A 126, Class B.
   b) With machined seat for screen retention.
   c) Galvanized as required to match connecting piping.
3) Cover flange:
   a) Cast iron, ASTM A 126, Class B.
   b) With machined seat for screen retention.
   c) With female tapped NPT blowoff connection.
   d) With EPDM o-ring seal.
4) Screen:
   a) To 8 inches: 3/64 inch perforations.
   b) 10 inches and larger: 1/16 inch perforations.
   c) 304 stainless steel, ASTM 240.
   d) Free area not less than 2.5 times inlet area.
5) Blowoff outlet: With female NPT tapping.
6) Mueller Model No. 752,

2. High pressure steam and high pressure condensate return systems of steel construction in excess of 15 psig to 100 psig.

a. Working pressure: To 450 psig @ 650°F.

1) Sizes 1/4 inch to 2 inches: ANSI Class 300.
2) Connections: Threaded.
3) Body:
   a) Ductile iron, ASTM A 536, Grade 65-45-12.
   b) With tapered self-aligning seat.
   c) Galvanized as required to match connecting piping.
4) Cap: Ductile iron, gasketed.
5) Screen:
   a) 3/64 inch perforations.
   b) 304 stainless steel, ASTM 240.
   c) Free area not less than 2.5 times inlet area.
6) Blowoff outlet: With female NPT tapping.
7) Mueller Model No. 251-DI.

b. Working pressure to 150 psig @ 565°F, ANSI Class 150:

1) Sizes 1/2 inch to 12 inches:
   a) Connections: Flanged or butt welded to match piping system.
   b) Body: Carbon steel, ASTM A 216, Grade WCB. With machined seat for screen retention cover.
   c) Cover: Carbon steel, ASTM A 216, Grade WCB. With machined seat for screen retention. With female tapped NPT blowoff connection. With non-asbestos gasket.
   d) Screen: To 4 inches: 1/32 inch perforations. 5 inches and larger: 3/64 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.
   e) Blowoff outlet: With female NPT tapping.
   f) Mueller Model No. 761 for ANSI Class 150.

2) Sizes 14 inches to 24 inches:
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a) Connections: Flanged or butt welded to match piping system and application.

b) Body: Carbon steel, ASTM 216, Grade WCB. With machined seat for screen retention.


d) Screen: 1/16 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.

e) Blowoff outlet: With female NPT tapping.

f) Mueller Model No. 781 for ANSI Class 150.

3. High pressure steam and high pressure condensate systems of steel construction in excess of 100 psig:

a. Working pressure to 150 psig @ 565°F, ANSI Class 150 and 300 psig @ 838°F, ANSI Class 300:

   1) Sizes 1/2 inch to 12 inches:
      a) Connections: Flanged to butt welded to match piping system/
      b) Body: Carbon steel, ASTM A216, Grade WCB. With machined seat for screen retention.
      c) Cover: Carbon steel, ASTM A216, Grade WCB. With machined seat for screen retention. With female tapped NPT blowoff connection. With non-asbestos gasket.
      d) Screen: To 4 inches: 1/32 inch perforations. 5 inches and larger: 3/64 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.
      e) Blowoff outlet: With female NPT tapping.
2) Sizes 14 inches to 24 inches:
   a) Connections: Flanged or butt welded to match piping system and application.
   b) Body: Carbon steel, ASTM 216, Grade WCB. With machined seat for screen retention.
   d) Screen: 1/16 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.
   e) Blowoff outlet: With female NPT tapping.

2.6 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Minimum 3/8 carbon steel plate. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

B. Features:

1. Vertical tank.
2. Tangential inlet with 3/8 inch wear plate.
3. Protected gauge glass with 3/4 inch angle shutoff valves.
4. Low pressure steam outlet.
5. Condenser outlet.
6. Air vent.
7. Relief valve.
8. Support base
2.7 SAFETY VALVES

A. Bronze Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc
   e. Leslie.

2. Disc Material: Forged copper alloy.

3. End Connections: Threaded inlet and outlet.

4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

5. Pressure Class: 250.

6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc.
   e. Leslie.

2. Disc Material: Forged copper alloy with bronze nozzle.

3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.

4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.

2.8 STEAM PRESSURE-REDUCING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Leslie Controls, Inc.

B. Provide pneumatic PRV stations. Both stations have a safety shut-off valve because the final operating pressures are different. Each also has a pressure limiting pilot that will reset the primary PRV to the final pressure should the secondary PRV fail.

C. Provide an interface with the PRV control and alarm station provided by the unit manufacturer. The ATC system shall report and log alarm status and safety shut off valve status.

D. PRV shall be pneumatically actuated locally controlled with local alarm and control panel. ATC contractor to coordinate and provide for these systems.

E. Contractor shall furnish and install the pressure reducing valve station with all devices and controls specified below and as shown on the drawing.

F. Provide air compressor for PRV station pneumatic air.

G. Contractor shall furnish and install the pressure reducing valve station specified below and as shown on the drawing.

H. STEAM PRESSURE REDUCING VALVE STATION – Two Stage Regulation w/ Pressure Limiting Pilot and Safety Shut Off.
   1. Contractor shall furnish and install the pressure reducing valve station specified below and shown on the detail drawing.
   2. Pressure Reducing Valves (DDBOY, DDLO, GPK)
   3. Air operated diaphragm control valves.
   4. Steel body with ANSI 300psi rating.
5. Normally closed, air to open.
6. Renewable stainless steel stellited seat.
7. Stainless steel stellited inner valve with equal percent or modified linear flow characteristic.
8. Valves 2-1/2” and larger shall have a pressure balanced inner valve to minimize diaphragm actuator size.
9. Suitable for dead end service
10. Actuator shall be bolted to valve bonnet and capable of closing off control valve against 200 psig pressure drop.
11. Actuator shall have a manual handwheel override.
12. Valve shall be packless with stainless steel 2 ply diaphragms.
13. All internal parts of the valve shall be replaceable without removing valve from line or disturbing pipe connections.
14. Valve shall be heavy duty industrial grade similar to Leslie DDLO, DDBOY, GPK or approved equal.
15. Automatic Safety Shutdown System w/ Manual Reset - Contractor shall furnish and install the number of Safety Shutdown valves as indicated in the PRV schedule. The automatic shutdown system shall consist of the following components.
16. Pneumatically operated diaphragm control valve similar to that specified for the pressure reducing valves above. Leslie Class DDLO, DDBOY, or GPK as indicated in the schedule.
17. Air filter regulator for dedicated supply to 3 way solenoid valve. Similar to Leslie Class AFG-2 with air output gage, 0-30 psig.
18. Pneumatic Non-Indicating and Pressure Limiting
19. Non-indicating with spring adjustment.
20. Force balance relay type capable of operation with zero air consumption in the steady state condition.
21. Furnish with air supply and output gages.
22. Capable of full air output with a steam pressure deviation 25psig.
23. Reverse acting with air output volume of 3SCFM.
24. Similar to Leslie Model PRA, PRAP and PRQ or approved equal.

I. Pneumatic Indicating Controllers

1. Pneumatic indicating pressure controllers shall have dual pointer indicating set pressure and actual pressure, two mode control including gain (1-50) and Integral Reset (.1-20 rpm), stainless steel helical pressure sensing element, stainless steel internal pneumatic tubing, 3-27 psi air output with output gage and all stainless steel internal linkage. Controller shall be industrial grade, Leslie P-III or approved equal.
J. Pneumatic Accessories

1. Pneumatic controllers shall be furnished with an air filter regulator with output gage.
2. Aluminum body, enclosed spring case and filter case.
3. Rated supply pressure 200 psig air.
4. Adjusted output range as specified by manufacturer for the intended application.
5. Supply pressure effect shall be minimum 65 to 1.
6. Leslie AFG-2 Airmate or approved equal

K. Pressure Switches

1. Valve supplier shall furnish 2-stage dual high/low pressure switches for purpose of activating PRV station alarms. ASCO SC10D/TG10A21 or approved equal
2. Diaphragm type mercury free with minimum static pressure rating of the brass transducer as follows.
   a. For high pressure lines 400 psig
   b. For medium pressure lines 200 psig
   c. For low pressure lines 150psig
3. Construction shall be modular type with transducer, switch housings and adjustments in separate areas.
4. In applications where the switch is used in conjunction with a Safety Shut Off system it shall be proved with a manual reset button. ASCO SD20D/TE20121 or approved equal
5. Switches shall be field wired as indicated on the detail drawing to the Local alarm panel.
6. Mount all pressure switches on pigtail siphon to isolate transducer from steam temperatures.

L. Alarm Panel to Interface with PRV Station Pressure Switches. – Contractor shall furnish and install a local 8 point alarm panel which shall be located in accordance with the building owner’s instruction or as specified herein. Power to this panel shall be 120VAC/60HZ and shall be furnished by this contractor or his electrical sub-contractor. Panel shall meet the following requirements:

1. NEMA 1 enclosure with hinged door.
2. Fused on/off switch with power on light (Green).
3. Six alarm lights (Red).
4. One common alarm bell (85dba).
5. Eight silencing buttons. The silencing of one point shall not effect the remaining points which shall remain active.
6. Extra set of terminals on the bell circuit with relay for interface with remote alarm.
7. Numbered terminal strip for wiring of PRV station pressure switches.
8. Similar to LPI Controls Model AP8

M. Noise suppressors

1. The contractor shall provide sound attenuator equipment attached to the outlet of the pressure reducing valve, to reduce noise to a level of 80dBA or lower.
2. A low attenuation (less than 5dBA) sound diffractor containing an inlet flow nozzle with holes shall be provided.
3. Diffusers are constructed of all welded carbon steel pipe, plate and fittings.
4. Design is to the procedures of ASME code Section 8, Div. 1, excluding hydrotesting and stamp.
5. Noise suppressor to be Quietflo LDF-IV or approved equal.

N. Sequence of operation

1. Each reducing valve shall open gradually without chatter or vibration and shall maintain set pressure throughout its rated travel.
2. PRV shall be capable of operating with the full primary pressure at the inlet and shall maintain a desired setpoint while operating under the condition.
3. Should the PRV fail to maintain proper pressure, then the safety shut off shall automatically close to prevent system from exceeding desired setpoint.
4. A failure of the PRV shall cause an alarm indication at the local alarm panel.
5. Each reducing valve shall be equipped with its own dedicated pneumatic controller. Use of positioners and booster relays shall not be permitted.

O. Automatic safety shutdown system with manual reset:

1. Contractor shall furnish and install the number of safety shutdown valves as indicated on the drawing. The automatic shutdown system shall consist of the following components.
2. Pneumatically operated diphram control valve similar to that specified for the pressure reducing valves above. Leslie DDBOY or approved equal.
3. Air filter regulator for dedicated supply to 3 way solenoid valve. Leslie class AFG-2 or approved equal with output gage, 0-30 psig. Regulator shall be adjusted to 22 psig.
4. Performance specifications of all settings shall be field adjusted and reported to the owner in writing as follows:
5. Single stage reduction – per schedule
6. Manual reset setting – 2 psig above (B) +/- .5 psig

P. Air handling capacity of various control shall be as follows:
1. Single stage controllers – 3 SCFM min.
2. Air supply regulators – 28 SCFM at 100 psig inlet

Q. Steam pressure reducing station major components such as:
1. Steam control valves
2. Pressure reducing/regulating valves
3. Pneumatic pressure controllers
4. Automatic limit controllers
5. Air filter regulators
6. Load transfer relays

R. By-Pass Valves
1. Eccentric Plug Rotary Control Valves with carbon steel body and 300# flanges
2. Metal to metal seating with ANSI class V shut-off capability
3. Manual multiturn gear operated handwheel
4. Leslie K-MAX valve or approved equal.

S. High performance shut off valves for steam PRV station and HP steam piping.
1. Contractor shall furnish and install the number of high performance shutoff valves as indicated on the drawings and pressure reducing valve schedule. Valves shall meet the following specifications:
   a. Shut-off valve shall be ball valves with:
      1) Carbon steel body with ANSI 300# flanges
      2) Floating 316 SS ball and 316 SS stem
      3) PEEK seats
      4) Live loaded graphite stem packing
      5) Spiral wound 316/graphite body seals
      6) Handwheel gear operator with mechanical position indicator
      7) Certified fire safe
      8) As Manufactured by Flow-Tek Model F30 or approved equal
T. Safety relief valves

1. Outlet of safety relief valve to have drip pan elbow and terminate in a gooseneck, at least 6 feet above roof.

U. Source & Responsibility of Steam Station

1. Shall be furnished by one manufacturer who shall take full responsibility for the control function specified and intend by the Consulting Engineer’s steam reducing station design.
2. Packages put together by one manufacturer by third party suppliers/distributors using different manufacture’s equipment is not permitted and shall be summarily rejected without review.
3. Manufactures which are proposed as meeting the specifications shall provide the following with the submitted documents:
   a. References with names and phone numbers of successful installations in operation a minimum of 5 years.
   b. Manufacturer’s unconditional 3 year warranty.

V. AIR COMPRESSOR FOR STEAM PRV

1. Provide a duplex type air compressor set complete with air tank, motors, V-belt drives, pressure switches, relief valve, pressure gauge, intake filter silencers, starters, electric alternator, and all other items and accessories. The two compressors shall be mounted on ASME National Board receiving tank. The entire unit shall be factory piped and wired. Compressor shall be sized as necessary to supply all pneumatics.
2. The air compressor shall be suitable for 70 – 90psi working pressure and shall be capable of supplying compressed air at 80psi under maximum CFM and be capable of maintaining 15/20psi air pressure (nominal) in the entire system with the compressor in operation less than 1/3 of the time that is required, and at a speed of 450rpm. Each compressor shall be single stage, one or two cylinders, air cooled, with drop forged steel crankshaft supported on both ends by means of ball, roller or sleeve main bearings. Lubrication shall be of the constant level splash type, or of the pressure type, to assure adequate supply of oil to all working parts. Compressor shall be provided with oil proof piston rings.
3. The air compressors shall be connected to an ASME air storage vessel of sufficient size to prevent in excess of 6 starts/hr.
4. Each compressor motor shall be provided with a magnetic starter with disconnect, three overload relays, and pressure switch. Provide an electric alternator to alternate
automatically the starting sequence of the compressor motors. Electric controls shall be 
factory installed on the unit. A complete wiring diagram shall be secured to the interior 
of the cabinet door.

5. Compressor unit shall be painted with a prime and finish coat of paint in accordance 
with the manufacturers standard practice. Air tank shall be provided with a drain 
opening at the bottom, which shall be piped near the floor with gate valve and 
discharge into a floor drain.

W. AIR DRYER SYSTEM

1. Provide in parallel (2) refrigerated air dryers for the compressed air system, one piped 
as a standby. Each unit shall consist of a hermetically sealed, direct connected 
refrigerant compressor and motor unit, automatic drain valve, non-toxic refrigerant, 
automatic expansion valve, condenser, lubrication system insulation, and other items 
and accessories, contained in a wall mounted cabinet. The air dryers shall be 
connected in to the high-pressure side of the compressed air line with copper tubing 
between the air tank and the pressure reducing station. Each unit shall be non-cycling 
type, with sufficient capacity to chill the compressed air output of one compressor, to a 
dewpoint of 35°F with an inlet air temperature of 100°F air (based on 110°F ambient 
temperature) required for normal temperature control system operation. Air dryers shall 
be piped with manual bypass.

2. Provide a compressed air pressure reducing station complete with two (2) air filters, 
two (2) oil filters, reducing valves, safety valves, isolating valves, gauges, brass piping 
and fittings. The use of type K copper tubing with brass or copper solder joint fittings 
is also acceptable for assembling this station. The reducing station shall be wall 
mounted adjacent to the air compressor and in each MER. Equipment and piping 
shall be arranged to provide identical parallel paths for the compressed air to be 
discharged to the temperature control system at the reduced pressure required for the 
mode of operation.

3. Provide a replaceable media cartridge type particulate and oil filters in the air piping 
between the refrigerated dryer and the pressure reducing station. Filters shall be so 
designed that the media can be replaced without removing the entire unit from the 
piping. A drain, with valve or petcock, shall be provided at the bottom of the filter 
assembly. Provide, per air pressure reducing station, two (2) pre-filters and two (2) oil 
filters, each sized for the compressed air requirements. Filters shall provide a dirt and 
oil free system. Isolation and changeover valves shall permit uninterrupted service 
during maintenance.

4. Provide 2 pressure reducing valve parallel branches, each branch having a minimum 
of three, ½” pressure reducing valves. These valves shall reduce the air pressure, in
stages, from 80psi to 30psi – 19psi – 15psi. (these pressures are nominal and may differ from manufacturer to manufacturer)

5. Provide an approved make ASME standard bronze safety valve at the air tank and after each pressure reducing valve. The safety valve at the air tank shall be 3/4”, set at 80psi and each safety valve after the primary reducing valve shall be ½”, set at 38psi. Safety valves after the other pressure reducing valves shall be ½”, set approximately 5psi higher than the setting of the reducing valve it follows. Safety valves shall be Crosby Valve & Gauge Co., Kunkle Valve Co. or J.E. Lonergan Co.

6. Provide compressed air system sized for system requirements plus 50% spare capacity.

X. AIR GAUGES

1. Provide air pressure gauges on all main compressed air systems including, main station, air filters, pressure reducing valves, etc. Gauges shall have a 2-1/2” diameter, minimum.

2. Provide air pressure gauges on controlled equipment compressed air signals. Gauges shall be 1-1/2” in diameter, minimum.

Y. TUBING

1. All tubing shall be copper, ASTM L, or black single tube polyethylene ASTM type 1, gauge 5, class C, self-extinguishing (FR) plastic.

Z. Copper Tubing

1. Provide ASTM B75 or ASTM B88 rated tubing. Tubing having an outside diameter .375” and larger shall have a minimum wall thickness equal to ASTM B88, type M. Tubing having an outside diameter less than .375” shall have a minimum wall thickness of .025”. Concealed tubing shall be hard rack multiple tubing. Tubing for working pressures greater than 30 psi shall be hard copper. Racked and individual tubes shall be permanently identified at each end. Fittings shall be solder type ANSI 16.18 or ANSI/ASME B16.22, using ASTM B32, 95-5 tin-antimony solder, or compression type ASME/ANSI B16.26.

2. Exposed tubing shall be copper or plastic in EMT. In concealed but accessible locations, tubing shall be copper or plastic in EMT or jacketed bundled tubing. In concealed inaccessible areas, tubing shall be copper, plastic in EMT or multtube bundle with 30% spare capacity. Thermostat mains and branches, when run vertical in a wall, may be copper or plastic.

3. Identification of tubes: The individual tubes shall be consecutively numbered starting with the first system. As a number is assigned to a tube, that number will appear at the
terminating points of that tube (e.g., if Tube 2 was the number given to a master
outside air reset signal, wherever that tube entered a panel, etc., it would still be Tube
2). Provide for spare numbers at each local panel.

AA. COMPRESSED AIR SUPPLY

1. Accessories: Accessories shall be automatic traps on compressed air storage tanks,
   air dryers piped to drain, high-efficiency pre-filters, after filters for 99% oil and
   0.3micron solid particle removal, intake silencers, relief valves, pressure switches and
   gauges and refrigeration type air dryer to maintain 38°F dewpoint, drains, bypasses,
   shutoff valves and vibration isolators for compressors and piping. Vibration isolators
   shall be in accordance with Section Vibration Isolation.

2.9 STEAM SEPARATORS

A. Construction:

   1. Factory fabricated.
   2. Welded carbon steel in accordance with ASME Boiler and Pressure Vessel Code,
      stamped.
   3. Working pressure: 300 psig wsp.
   5. Horizontal orientation.

B. Features:

   1. Fixed internal vortex containment plate which shall remove 99.9% of all liquid and
      solid entrainment for particles 10 microns and larger.
   2. Protected gauge glass with angle shutoff valves.
   3. Cast steel bucket trap suitable for full line capacity at 100 psig.
   4. Size: As indicated on the drawings.

2.10 CONDENSATE COOLER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the
   following:

   1. Leonard Powers , Inc. (Wendland)
2. Wilson

B. Provide an ASME rated condensing unit with the number of inlet as required on plans. The sizing of the unit shall be based on pounds of condensate per hour discharge at high, medium, and low pressure.

C. Furnish unit with ASME code stamp rated not less than 200 PSIG.

D. Unit shall be manufactured in accordance with ASME pressure vessel code and code stamped.

E. Shell and head shall be constructed of 5/16” SA 285 grade C steel.

F. Furnish stainless steel lining around full internal circumference of condensate discharge storage chamber.

G. Internal piping of condensate shall be centrifugal with stainless steel wear plates in path of condensate as per manufacturers recommendations.

H. Provide unit with condensate inlet connections not less than 2 inch, vent, not cold water 1½” size and drain connections, refer to plans for sizes.

I. In addition, unit shall be furnished with bottom flush out connection per manufacturer’s standard and connections for inspection, thermometer, temperature regulator sensing bulb and magnesium anode insertions.

J. Accessories:

1. Provide Leslie Class GTRK all cast iron temperature control valve with stainless steel trim.
2. Thermal element shall be replaceable and furnished with 10 fee plain brass capillary tubing. Adjustable range 50 – 250 deg F.
3. Unit shall be suitable for 100 psig cold water pressure and contain a yield spring mechanism to protect internal parts from stress due to over temperature conditions.
4. Cast bronze check valve and Y strainer for cold water supply to be GTRK regulator.
5. Provide backflow preventor.
6. 5¼ Inch dial thermometer range 40 to 400 deg F.
7. High pressure condensate inlet, see plans for sizes and quantity of connections.
8. Low pressure condensate inlet see plans for sizes and quantity of connections.
9. 1/4 inch NPT back-connected dial thermometer.
10. 1/2 inch connection for pressure gauge.
12. Equip unit with replaceable magnesium-anode.
13. Dial thermometer: One-inch self-contained bronze body with stainless steel internals
14. floor mounting legs with welded brackets to pressure vessel.
15. For overhead mounting the support lugs shall be welded to the top of the unit and the
floor stand shall be eliminated.
16. Products shall be in successful operation on a high pressure steam system for 5 years..
17. All inlet connections shall enter the tank through an internal elbow with perforated dip
tube as to discharge below the normal water level.
18. As approved by Consolidated Edison.

2.11 STEAM TRAPS

A. Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of
the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.
2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Maximum allowable Pressure: 125 psig
7. The maximum operating pressure is to be selected for the intended service

B. Thermodynamic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of
the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.
4. Disc and Seat: Stainless steel.
5. Maximum allowable Pressure: 600 psig to 800 deg F.
6. The maximum operating pressure is to be selected for the intended service.

C. Float and Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.
2. Body and Bolted Cap: ASTM A 126, cast iron.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
10. Maximum allowable Pressure: 125 psig up to 450 deg F.
11. The maximum operating pressure is to be selected for the intended service.

D. Inverted Bucket Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Barnes & Jones, Inc.
   c. Hoffman Specialty; Division of ITT Industries.
   d. Spirax Sarco, Inc.
2. Body and Cap: Cast iron.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
10. The maximum operating pressure is to be selected for the intended service.

2.12 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of
   the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze or stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Maximum allowable Pressure: 125 psig or 300 psig.
7. The maximum operating pressure is to be selected for the intended service.
8. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of
   the following:
   b. Hoffman Specialty; Division of ITT Industries.
   c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
5. O-ring Seal: EPR.
6. Pressure Rating: 125 psig or 300 psig.  
7. Maximum Temperature Rating: 350 deg F.  

2.13 STEAM METERS  

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  
1. EMCO Flow Systems; Division of Advanced Energy Company.  
2. ISTEC Corp.  
3. Preso Meters; a division of Racine Federated Inc.  
4. Spirax Sarco, Inc  
5. Foxboro.  

B. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.  
1. Computer shall have 4 to 20-mA or 2 to 10 volt output for temperature, pressure, and contact closure for flow increments.  
2. Independent timers to store four peak flow rates and total flow.  
3. Interface compatible with central workstation described in Division 23 Section "Instrumentation and Control for HVAC."  

C. Sensor: Venturi, of stainless-steel construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.  

D. Sensor: Vortex type with stainless-steel wetted parts and flange connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.  

E. Sensor: Spring-loaded, variable-area flowmeter type; density compensated with stainless-steel wetted parts and flange connections. At least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.  

2.14 CONDENSATE METERS  

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:  

AKF
1. Lincoln Meter Company.

B. Description: Calibrated-volumetric type; measures flow directly in gallons per hour or pounds per hour.

C. Construction: Unit shall have a drum with compartments that measure liquid volumetrically. Stainless steel drum and shaft and plastic turbine or impeller, with integral direct-reading scale.

D. Pressure Rating: 15 psig maximum.

E. Temperature Rating: 212 deg F maximum

F. Accuracy: plus or minus 1 percent.

G. Body: Cast iron, bronze, or brass.

H. Turbine: Copper, brass, or stainless steel.

I. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2 1/2.

J. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-volt output for temperature, pressure, and contact closure for flow increments.

2. Independent timers to store four peak flow rates and total flow.

3. Interface compatible with central workstation specified in Division 23 Section "Instrumentation and Control for HVAC."


5. Provide remote LCD report with sensor mounted on meter and 20 feet of cable (prewired).

K. Condensate meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Hersey measurement company

3. ISTEC Corp.

4. Working pressure: 250 psig @ 250°F.
5. Self-contained, volumetric construction with casing, disc and ball internal parts, carbon steel. All other parts shall be bronze.

6. Horizontal straight reading totalizer register reading in pounds of condensate.

7. Connections:
   a. To 2 inches: Screwed.
   b. 2-1/2 inches and larger: Flanged.

8. Positive displacement turbine.

9. With magnetic coupling counter.

10. Accuracy shall be plus or minus 2 percent of actual flow rate over entire range and meters shall be capable of measuring temperature overloads up to 150 percent of rated capacity.

2.15 PIPE FLANGE GASKET MATERIALS

A. Flange gaskets shall be one-piece ring type 1/16 inch thick (minimum) except as noted, suitable for temperature, pressure (operating and test) and service of system.

1. For high pressure steam and condensate – Garlock, Style 9800 only
2. For low pressure steam and condensate - Klinger C4430
3. For joints of dissimilar metals, provide isolating gaskets, sleeves and washers between flanges, bolts and nuts. Gaskets shall be similar to Dupont Teflon.
4. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.
5. Narrow Face Type: For raised face, class 250, cast iron flanges.

2.16 RING SPACERS AND TEST BLANKS:

A. Provide between flanges where shown on drawing or where necessary to isolate equipment from the piping system, in accordance with B 3.1.1, Chapter VI, section 137.2.4. Ring spacers to be replaced by test blanks during hydrostatic testing and/or during chemical cleaning for equipment isolation.

B. Size and rating to match companion flanges.
2.17 STEAM PIPING APPLICATIONS

A. High pressure steam system, in excess of 225 psig to 300 psig total temperature below 650 deg F:
   1. Material shall be steel in accordance with ASTM A106 or A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 16 inch: 0.375 inch wall thickness, butt weld ends only.
      d. 18 inch to 20 inch: 0.375 inch wall thickness, butt weld ends only.
      e. 24 inch: 0.500 inch wall thickness, butt weld ends only.

B. High pressure steam system, in excess of 100 psig to 225 psig, total temperature below 450 deg F:
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 24 inch: 0.375 inch wall thickness, butt weld ends only.

C. High pressure steam system, in excess of 15 psig to 100 psig total temperature not exceeding 450 deg F:
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 24 inch: 0.375 inch wall thickness, butt weld ends only.

D. Low pressure steam system, 15 psig or below:
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80 with threaded ends, or Schedule 40 with socket welds.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
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E. Below atmospheric (vacuum) return system:
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 24 inch: 0.375 inch wall thickness, butt weld ends only.

F. High pressure condensate return system, above 100 psig:
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 80, butt weld ends only.
      c. 12 inch and larger: Schedule 80, butt weld ends only.

G. High pressure condensate return system, between 15 psig and 100 psig
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 80, butt weld ends only.
      c. 12 inch and larger: 0.375 wall thickness, butt weld ends only.

H. Low pressure condensate return system, below 15 psig:
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80 with threaded ends, or Schedule 40 with socket welds.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch and larger: 0.375 wall thickness, butt weld ends only.

I. Pumped condensate return system:
   1. Material shall be steel in accordance with ASTM A53 Grade B seamless.
2. Wall thickness shall be:
   a. To 2 inch: Schedule 80 with threaded ends, or Schedule 80 with socket welds.
   b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
   c. 12 inch and larger: 0.375 wall thickness, butt weld ends only.

2.18 ANCILLARY PIPING APPLICATIONS

A. Makeup-water piping installed above grade shall be the following:
   1. Drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

B. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

C. Air-Vent Piping:
   1. Inlet: Same as service where installed.
   2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

D. Vacuum-Breaker Piping: Outlet, same as service where installed.

E. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

2.19 LP STEAM-TRAP APPLICATIONS

A. Thermostatic Traps: Convectors and finned-tube radiation.

B. Float and Thermostatic Traps: Steam main and riser drip legs, laundry equipment, kitchen equipment, heat exchangers, and heating coils.

C. As indicated on the drawings.

2.20 HP STEAM-TRAP APPLICATIONS

A. Thermostatic Traps: Convectors and finned-tube radiation.

B. Inverted Bucket Traps: Steam main and riser drip legs, and laundry equipment.
C. Float and Thermostatic Traps: Kitchen equipment, heat exchangers, and heating coils.

D. Thermodynamic Traps: Steam main and riser drip legs, and heat tracer lines.

E. As indicated on the drawings

2.21 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
   1. Shutoff Duty: Gate and ball valves.
   2. throttling Duty: Globe and ball valves.

B. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

2.22 Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping to safe termination point in accordance with building codes, without valves, as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

2.23 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.

D. Install hangers with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 21 feet; minimum rod size, 5/8 inch.
9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 26 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 30 feet; minimum rod size, 7/8 inch.
12. NPS 14: Maximum span, 32 feet; minimum rod size, 1 inch.
13. NPS 16: Maximum span, 35 feet; minimum rod size, 1 inch.
14. NPS 18: Maximum span, 37 feet; minimum rod size, 1-1/4 inches.
15. NPS 20: Maximum span, 39 feet; minimum rod size, 1-1/4 inches.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 6 feet; minimum rod size, 1/4 inch.
2. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 8 feet; minimum rod size, 1/4 inch.
4. NPS 1-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 14 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

G. Vertical piping:

1. Base elbow support: Provide bearing plate on structural support, similar to F&S Manufacturing Co. Fig. 720 or 721.
2. Provide guides at every third floor but not exceed:
3. 25 ft for piping to 2 inch.
4. 36 ft for piping 2-1/2 inch to 12 inch.
5. 50 ft for piping 14 inch and larger.
6. Top support: Provide special hanger or saddle in horizontal connection and make provisions for expansion.
7. Intermediate supports: Steel pipe clamp at floor. Bolt and weld to pipe with extension ends bearing on structural steel or bearing plates.
8. For multiple pipes, coordinate guides, bearing plates and accessory steel.

2.24 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush system with clean water. Clean strainers.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
   3. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   4. Perform radiographic examination of butt welds in high pressure steam piping and condensate piping.

C. Prepare written report of testing.

END OF SECTION 23 2213
STEAM CONDENSATE PUMPS
SECTION 232223 - STEAM CONDENSATE PUMPS

PART 1 - APPROVED MANUFACTURERS

1.1 SUMMARY

A. This Section includes electric-driven and pressure-powered steam condensate pumps.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain steam condensate pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of steam condensate pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump’s operating point on curves. Include receiver capacity and material.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.


C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
D. Factory quality control and test reports

E. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Armstrong
   2. Bell & Gossett
   3. Spirax Sarco

2.2 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

A. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.

B. Configuration: Simplex and Duplex floor-mounting pump with receiver and float switch(es); rated to pump 200 deg F steam condensate.

   1. Manufacturers:
      a. Domestic Pump; Div. of ITT Industries.
      b. Spirax Sarco, Inc.

   2. Receiver: Floor-mounting, close-grained cast iron or welded steel; with externally adjustable float switch(es), and flange(s) for pump mounting.

   3. Pump(s): Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case ring and mechanical seal; mounted on receiver flange.

   4. Factory Wiring: Between pump(s) and float switch(es), for single external electrical connection. Fused control power transformer if voltage exceeds 230 V.

   5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate if the normal start level for a single pump is exceeded.

C. Configuration: Duplex floor-mounting pump with receiver and float switches; rated to pump 210 deg F steam condensate.
1. Manufacturers:
   a. Domestic Pump; Div. of ITT Industries.
   b. Spirax Sarco, Inc.

2. Receiver: Floor-mounting, close-grained cast iron or welded steel with externally adjustable float switches and flanges for pump mounting.

3. Pumps: Regenerative turbine, close coupled, permanently aligned, and bronze fitted; with mechanical seals and an independent pump control circuit for each pump; mounted on base or receiver flange; rated to operate with a minimum of 2 feet of NPSH.

4. Factory Wiring: Between pumps and float switches, for single external electrical connection. Fused control power transformer if voltage exceeds 230 V.

5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate if the normal start level for a single pump is exceeded.

D. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 200 deg F 210 deg F steam condensate.

1. Manufacturers:
   a. Domestic Pump; Div. of ITT Industries.
   b. Spirax Sarco, Inc.

2. Receiver: Floor-mounting, close-grained cast iron or welded steel; externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.

3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.

4. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges; rated to operate with a minimum of 2 feet of NPSH.

5. Control Panel: NEMA 250, Type 12 enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
   a. Motor controller for each pump.
   b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.

d. Momentary contact "TEST" push button on cover for each pump.

e. Numbered terminal strip.

f. Disconnect switch.

g. Fused transformer for control circuit.

E. Configuration: Duplex floor-mounting pump with elevated receiver, float switches, and connecting piping; rated to pump 212 deg F steam condensate.

1. Manufacturers:
   a. Domestic Pump; Div. of ITT Industries.
   b. Spirax Sarco, Inc.

2. Receiver: Close-grained cast iron or welded steel, mounted on fabricated-steel supports; externally adjustable float switches; with water-level gage, steam condensate thermometer, pump discharge pressure gages, bronze isolation valves between receiver and pumps, and lifting eyebolts.

3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.

4. Pumps: Centrifugal, close coupled, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on base below receiver; rated to operate with a minimum of 2 feet of NPSH.

5. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106; Schedule 80; seamless steel.


7. Fittings NPS 2-1/2 and Larger: ASTM A 234/A 234M, steel, for welded connections.

8. Control Panel: NEMA 250, Type 12 enclosure with hinged door and grounding lug; mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
   a. Motor controller for each pump.
   b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
   c. Manual lead-lag control to override electrical alternator to manually select the lead pump.
   d. Momentary contact "TEST" push button on cover for each pump.
   e. Numbered terminal strip.
f. Disconnect switch.
g. Fused transformer for control circuit.

F. Configuration: Underground duplex pump with basin and float switches; rated to pump 200 deg F steam condensate.

1. Manufacturers:
   a. Domestic Pump; Div. of ITT Industries.
   b. Spirax Sarco, Inc.

2. Basin: Cast iron, with hub-type inlets.

3. Basin Cover: Cast iron or steel with gasketed openings for access, pumps, pump shafts, control rods, discharge piping, and vent connections.
   a. Anchor Flange: Cast iron, attached to basin, in location and of size required to anchor basin to concrete slab.

   a. Casing: Cast iron with open inlet.
   b. Shaft and Bearings: Stainless-steel shaft with oil-lubricated, bronze, intermediate sleeve bearings; 48-inch maximum intervals where basin depth is more than 48 inches; and grease-lubricated, ball-type, thrust bearings.
   c. Shaft Couplings: Flexible, capable of absorbing vibration.
   d. Seals: Mechanical; with carbon rotating ring, bearing on a ceramic seat held by a stainless-steel spring, and enclosed by a flexible bellows and gasket.
   e. Motors: Vertically mounted on cast-iron pedestal.
   f. Pump Discharge Piping: Manufacturer’s standard steel or bronze pipe, unless otherwise indicated.

5. Control Panel: NEMA 250, Type 12 enclosure with hinged door and grounding lug; mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
   a. Motor controller for each pump.
   b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
   c. Manual lead-lag control to override electrical alternator to manually select the lead pump.
   d. Momentary contact "TEST" push button on cover for each pump.
2.3 PRESSURE-POWERED STEAM CONDENSATE PUMPS

A. Manufacturers:
   1. Armstrong Fluid Handling; Div. of Armstrong International, Inc.
   2. Spirax Sarco, Inc.

B. Description: Factory-fabricated, pressure-powered pumps with mechanical controls, valves, piping connections, and accessories suitable for pumping steam condensate using steam.

C. Configuration: Simplex and Duplex pump with float-operated valve control.

   2. Piping Connections: Threaded; for steam condensate, operating medium, vent, and indicated accessories.
   3. Level Gage: Glass site gage with shutoff cocks.
   4. Valves: Manufacturer’s standard check valves on inlet and outlet.
   5. Internal Parts: Stainless-steel float, springs, and actuating mechanism.
   7. Receiver: Cast iron or welded steel, factory mounted on steel supports; with water-level site glass and threaded piping connections.
   8. Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106; Schedule 80; seamless steel.

2.4 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

END OF SECTION 23 2223
REFRIGERANT PIPING
PART 1 - SECTION 232300 - REFRIGERANT PIPING

1.1 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."


C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
a. The contractor to confirm with the manufacturer and provide quantity, size and all required accessories as part of this project.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

F. Field quality control and test reports

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers of refrigerants:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L and ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
5. Maximum Operating Temperature: 250 deg F.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.


E. Flanged Unions:
   1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
   2. Gasket: Fiber asbestos free.
   3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
   4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
   5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   7. Maximum Operating Temperature: 330 deg F.

F. Flexible Connectors:
2. **End Connections:**
   a. NPS 2 and Smaller: With threaded-end connections.
   b. NPS 2-1/2 and Larger: With flanged-end connections.

3. **Offset Performance:** Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.

4. **Pressure Rating:** Factory test at minimum 500 psig.

5. **Maximum Operating Temperature:** 250 deg F.

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### 2.4 VALVES AND SPECIALTIES

**A. Diaphragm Packless Valves:**

1. **Body and Bonnet:** Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. **Diaphragm:** Phosphor bronze and stainless steel with stainless-steel spring.
3. **Operator:** Rising stem and hand wheel.
4. **Seat:** Nylon.
5. **End Connections:** Socket, union, or flanged.
6. **Working Pressure Rating:** 500 psig.
7. **Maximum Operating Temperature:** 275 deg F.

**B. Packed-Angle Valves:**

1. **Body and Bonnet:** Forged brass or cast bronze.
2. **Packing:** Molded stem, back seating, and replaceable under pressure.
3. **Operator:** Rising stem.
4. **Seat:** Nonrotating, self-aligning polytetrafluoroethylene.
5. **Seal Cap:** Forged-brass or valox hex cap.
6. **End Connections:** Socket, union, threaded, or flanged.
7. **Working Pressure Rating:** 500 psig.
8. **Maximum Operating Temperature:** 275 deg F.

**C. Check Valves:**

1. **Body:** Ductile iron, forged brass, or cast bronze; globe pattern.
2. **Bonnet:** Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. **Piston:** Removable polytetrafluoroethylene seat.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   4. End Connections: Copper spring.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24 115-208-V ac coil.
   7. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   4. End Connections: Threaded.
   6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 450 psig

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
5. Seat: Polytetrafluoroethylene.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24 115 208-V ac coil.
10. Throttling Range: Maximum 5 psig.
12. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
5. End Connections: Socket or flare.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
7. Maximum Pressure Loss: 2 psig
10. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with ARI 730.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
7. Maximum Pressure Loss: 2 psig
10. Maximum Operating Temperature: 240 deg F.

N. Mufflers:
2. End Connections: Socket or flare.
4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
7. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with ARI 495.
2. End Connections: Socket or threaded.
4. Maximum Operating Temperature: 275 deg F.

2.5 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.

B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

2.6 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-22:
3. Hot-Gas and Liquid Lines: 325 psig.

B. Line Test Pressure for Refrigerant R-134a:

C. Line Test Pressure for Refrigerant R-407C:

D. Line Test Pressure for Refrigerant R-410A:

2.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."


C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

2.8 PIPING APPLICATIONS FOR REFRIGERANT R-134A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR L, drawn-temper tubing and wrought-copper fittings with brazed joints.
C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.


E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
   1. NPS 1-1/2 and Smaller Copper, Type K and L, drawn-temper tubing and wrought-copper fittings with brazed joints.
   2. NPS 2 to 4 Copper, Type K and L, drawn-temper tubing and wrought-copper fittings with brazed joints.

F. Safety-Relief-Valve Discharge Piping:
   1. NPS 1-1/2 and Smaller Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
   2. NPS 4 Copper, Type K and L, drawn-temper tubing and wrought-copper fittings with brazed joints.

2.9 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR L, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
   1. NPS 1 and Smaller Copper, Type ACR and L, drawn-temper tubing and wrought-copper fittings with brazed joints.
   2. NPS 1-1/4 to NPS 2 Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
   3. NPS 2 TO4 Copper, Type K and L, drawn-temper tubing and wrought-copper fittings with brazed joints.

D. Safety-Relief-Valve Discharge Piping:
   1. NPS 1 and Smaller Copper, Type ACR and L, drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 1-1/4 to NPS 2 Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
3. NPS 2 to 4 Copper, Type K drawn-temper tubing and wrought-copper fittings with brazed joints.

2.10 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
B. Suction Lines NPS 2 to NPS 3-1/2 for Conventional Air-Conditioning Applications: Copper, Type ACR L, drawn-temper tubing and wrought-copper fittings with brazed joints.
C. Suction Lines NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR K drawn-temper tubing and wrought-copper fittings with soldered joints.
D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications NPS 2 to NPS 4 Schedule 40, black-steel and wrought-steel fittings with welded joints.
F. Safety-Relief-Valve Discharge Piping:
   1. NPS 5/8 and Smaller Copper, Type ACR and L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
   2. NPS 3/4 to NPS 1 and Smaller Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
   3. NPS 1-1/4 and Smaller Copper, Type K and L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
   4. NPS 1-1/2 to NPS 2 Copper, Type K and L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
G. Safety-Relief-Valve Discharge Piping NPS 2 to NPS 4 Schedule 40, black-steel and wrought-steel fittings with welded joints.

2.11 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm pack-less valves in suction and discharge lines of compressor.
B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm pack-less valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.
M. Install flexible connectors at compressors.

2.12 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

END OF SECTION 23 2300
SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Biocide chemical-feed equipment and controls.
   3. Chemical treatment test equipment.
   4. HVAC water-treatment chemicals.
   5. Makeup water softeners.
   6. RO equipment for HVAC makeup water.
   7. Glycol feeder makeup package
   8. Water filtration units for HVAC makeup water.

1.2 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
   1. Bypass feeders.
   2. Water meters.
   3. Inhibitor injection timers.
   4. pH controllers.
   5. TDS controllers.
7. Chemical solution tanks.
8. Injection pumps.
9. Ozone generators.
10. UV-irradiation units.
11. Chemical test equipment.
12. Chemical material safety data sheets.
14. RO units.
15. Multimedia filters.
17. Bag- or cartridge-type filters.
18. Centrifugal separators.

B. Shop Drawings: Pretreatment and chemical, and ozone-generator biocide, and UV-irradiation biocide treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.


C. Field quality-control test reports.

D. Manufacturer Seismic Qualification Certification: Submit certification that water softeners RO equipment water filtration units and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
E. Operation and Maintenance Data: For sensors, injection pumps, water softeners, RO equipment, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.

F. Other Informational Submittals:
   1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

A. The following are base bid manufacturers:
   2. Barclay Chemical Co.; Water Management, Inc.
   3. GE Osmonics.
   5. Metro Group Inc. (The); Metropolitan Refining Div.
   6. ONDEO Nalco Company.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
   1. Capacity 5 gal
2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
5. Registration: Gallons or cubic feet.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.

B. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
5. Registration: Gallons or cubic feet.
7. Control: Low-voltage signal capable of transmitting 1000 feet.

C. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
5. Registration: Gallons or cubic feet.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.

D. Inhibitor Injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.

E. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low pH alarm light, trip points field adjustable; with silence switch.
7. Internal adjustable hysteresis or deadband.

F. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High or low conductance alarm light, trip points field adjustable; with silence switch.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:
a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.
b. Steam Boilers: Motorized ball valve, steel body, and TFE seats and seals.

G. Biocide Feeder Timer:
1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Division 23 Section "Instrumentation and Control for HVAC."
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two different formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup so clock is not disturbed by power outages.

H. Chemical Solution Tanks:
1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 50 gal.

I. Chemical Solution Injection Pumps:
1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

J. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
K. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.4 SELF CONTAINED BREATHING APARATUS

A. Self-Contained Breathing Apparatus: Open-circuit, pressure-demand, compressed air includes completely assembled, portable, self-contained devices designed for hazardous breathing environment application.

1. Face Piece: EPDM or silicone rubber construction material, one-size-fits-all with double-sealing edge, stainless-steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO$_2$ buildup, and perspiration drain to avoid skin irritation and to prevent eyepiece, spectacle, and lens fogging.
2. Backplate: Orthopedically designed of chemical and impact-resistant, glass-fiber composite.
3. Harness and Carrier Assembly: Large triangular back pad, backplate, and adjustable waist and shoulder straps. Modular in design, detachable components, and easy to clean and maintain. Shoulder straps padded with flame-resistant material, reinforced with stainless-steel cable, and attached with T-nuts, washers, and screws.
4. Air Cylinder: 60-minute, low-pressure, air-supply-loaded aluminum cylinders fitted with quick-fill assembly for refilling and air transfer.
5. Wall-Mounting Cabinet: Leakproof, corrosion-resistant, clear, plastic case.
6. Tested and Certified: By the National Institute for Occupational Safety and Health and by the Mine Safety and Health Administration, according to 42 CFR 84, Subpart H.

2.5 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.

C. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig SWP and 600-psig CWP rating.

2.6 GLYCOL FEEDER MAKEUP PACKAGE

A. The contractor shall supply and install, as indicated on the plans and in the specifications, a prefabricated, automatic and autonomous make-up package for each glycol system or one system to serve all system with isolation valuing.

B. The package shall be designed to occupy a minimum amount of floor space to operate on a standard 110V, 60Hz electrical circuit, and to maintain a fill pressure in the glycol system. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off the floor. It shall include a pump sized by treatment manufacturer, a motor, a magnetic starter, a pressure tank with a pressure control, a priming valve, a PRV, a shut-off valve and a pressure gauge. It shall be connected to the system with a ½” NPT connection.

C. It shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and active an audible (which can be silenced) and a visual alarm. A 110V shall also be available for a remote alarm. A translucent polyethylene (50) gallon solution container, complete with lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve. A glycol solution recovery line shall be piped in from the system relief valve outlet to the solution container, through its lid in such a way that the lid can be removed for filling and mixing.

D. The make-up package shall be Wessels Model GMP with discharge pressure factory preset and fixed adjustable.

2.7 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
1. Tube: Sample.
   a. Size: NPS 1/4 tubing.
   b. Material: ASTM A 666, Type 316 stainless steel.
   d. Temperature Rating: Minimum 850 deg F.

2. Shell: Cooling water.
   a. Material: ASTM A 666, Type 304 stainless steel.
   c. Temperature Rating: Minimum 450 deg F.

3. Capacities and Characteristics:
   a. Tube: Sample.
      1) Flow Rate: 0.25 gpm
      2) Entering Temperature: 400 deg F
      3) Leaving Temperature: 88 deg F
      4) Pressure Loss: 6.5 psig.
   b. Shell: Cooling water.
      1) Flow Rate: 3 gpm.
      2) Entering Temperature: 70 deg F.
      3) Pressure Loss: 1.0 psig.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.
2. Four-station rack for open systems.

2.8 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.
B. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.

2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.9 HVAC MAKEUP WATER SOFTENER

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Alamo Water Treatment; Ecodyne Water Treatment, Inc.
3. CSI; a division of Chandler Systems, Inc.
5. CUNO Incorporated.
8. Environmental Dynamics Corporation.
9. Hungerford & Terry, Inc.
11. Marlo Incorporated.
13. Plymouth Products, Inc.
14. Rainsoft Div.; Aquion Partners L. P.
15. Water King.

D. Description: Twin mineral tanks and one brine tank, factory mounted on skid.
E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.

F. Mineral Tanks:

1. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Fabricate and label FRP filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
4. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
5. Freeboard: 50 percent, minimum, for backwash expansion above the normal resin bed level.
6. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
7. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
9. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even-flow distribution through resin bed.

G. Controls: Automatic; factory mounted on mineral tanks and factory wired.

1. Adjustable duration of regeneration steps.
2. Push-button start and complete manual operation override.
3. Pointer on pilot-control valve shall indicate cycle of operation.
5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
   a. Slow opening and closing, nonslam operation.
   b. Diaphragm guiding on full perimeter from fully open to fully closed.
   c. Isolated dissimilar metals within valve.
   d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
   e. Float-operated brine valve to automatically measure the correct amount of brine to the softener and refill with fresh water.
f. Sampling cocks for soft water.

6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons, and automatically resets after regeneration to preset total in gallons for next service run. Include alternator to regenerate one mineral tank with the other in service.

H. Brine Tank: Combination measuring and wet-salt storing system.

1. Tank and Cover Material: Fiberglass a minimum of 3/16 inch thick; or molded PE a minimum of 3/8 inch thick.
2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
3. Size: Large enough for at least four regenerations at full salting.

I. Factory-Installed Accessories:

1. Piping, valves, tubing, and drains.
2. Sampling cocks.
3. Main-operating-valve position indicators.

J. Water Test Kit: Include water test kit in wall-mounting enclosure for water softener.

K. Capacities and Characteristics:

2. Peak Service Flow Rate: <Insert gpm> at 25-psig pressure loss.
3. Water Consumption: <Insert gal./day.>
4. Water Demand: <Insert number> hours/day.
5. Electrical Characteristics:
   a. Volts: <Insert value.>
   b. Phase: <Insert value.>
   c. Hertz: <Insert value.>
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
   f. Maximum Overcurrent Protection: <Insert amperage.>
2.10 RO EQUIPMENT FOR HVAC MAKEUP WATER

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Alamo Water Treatment; Ecodyne Water Treatment, Inc.
3. CSI; a division of Chandler Systems, Inc.
5. CUNO Incorporated.
7. Environmental Dynamics Corporation.
8. Hungerford & Terry, Inc.
10. Marlo Incorporated.
11. Plymouth Products, Inc.
12. Rainsoft Div.; Aquion Partners L. P.
14. Water King

D. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.

E. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.

F. Skid Assembly: Welded-steel frame coated with epoxy protective finish.

G. RO Membrane and Housing:
1. **Element:** Thin-film composite with U-cup brine seal with minimum 98 percent salt rejection based on 2000 ppm water supplied at 225 psig and 77 deg F.

2. **Housing:** ASTM A 666, Type 304 stainless steel with PVC end caps held in place with stainless-steel straps.

### H. High-Pressure Pumps and Motors:

1. **Pump:**
   a. Vertical, multistage centrifugal operating at 3500 rpm with ASTM A 666, Type 304 stainless-steel casing, shaft, impellers, and inlet and discharge casting.
   b. Bearings shall be tungsten carbide and ceramic.
   c. Cast-iron frame and flanged suction and discharge connections.

2. **Motor:** NEMA-standard, C-faced TEFC motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

### I. Controls:

1. Microprocessor-based controller with LCD display.
2. Interlock for remote start/stop control.
3. Membrane flush sequence when pumps shut down.
4. Run time indicator.
5. Low-pressure safety cutoff.
6. Panel-mounted gages as follows:
   a. Product and concentrate.
   b. Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.
   c. Product conductivity monitor.

### J. Valves:

1. Stainless-steel pump, concentrate, and recycle throttling valves rated for minimum 300 psig.
2. Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.
3. PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Sample valves at cartridge filter outlet, concentrate, and product outlet.

K. Prefilter:
   1. Housing: Polypropylene with built-in relief or vent valve.
   2. Element: Spun-wound polypropylene.

L. Inlet Water Tempering Valve: Thermostatic water-tempering valve to maintain 77 deg F inlet water temperature to RO unit.

M. Activated Carbon Filter:
   1. Media Tank: Fiberglass-reinforced polyester rated for minimum 150 psig with internal backwash distributor and filtered water collector.
   4. Backwash Control: Seven-day time clock.

N. Atmospheric Storage Tank:
   1. Tank: Polyethylene single piece with closed top and flat bottom with manway in top, 0.2-micron filter vent, inlet, discharge, and drain piping connections, and bulkhead fittings for level controls.
   2. Control: Level switches start and stop RO unit. Low-level limit shall stop repressurization pumps, and signal an alarm.

O. Repressurization Pumps:
   1. Pumps: Two close-coupled, single-stage centrifugal pumps, with mechanical seals. Wetted components ASTM A 666, Type 316 stainless steel.
   2. Controls: NEMA-4X pump control panel constructed of fiberglass to control pumps, one operating, one standby, with automatic alternator and fail-over control.
   3. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

P. Water Test Kit: Include water test kit in wall-mounting cabinet for RO unit.
Q. Capacities and Characteristics:

1. RO Product Flow Rate: <Insert gpm.>
2. Total Water Flow Rate: <Insert gpm.>
3. Daily Water Consumption: <Insert gal./day.>
4. Water Demand: <Insert number> hours/day.
5. Storage Tank Size: <Insert gal.>
6. RO Inlet Operating Temperature: 77 deg F <Insert value.>
7. High-Pressure Pump:
   a. Discharge Pressure: <Insert psig.>
   b. Flow Rate: <Insert gpm.>
   c. Horsepower: <Insert value.>
   d. Motor Speed: 3500 <Insert number> rpm.

8. Repressure Pumps:
   a. Discharge Pressure: <Insert psig.>
   b. Flow Rate: <Insert gpm.>
   c. Horsepower: <Insert value.>
   d. Motor Speed: 3500 <Insert number> rpm.

9. Prefilter Design (at Total Water Flow Rate):
   a. Filter Efficiency: 98 <Insert number> percent.
   b. Particle Size: 5 <Insert number> microns and larger.
   c. Clean Pressure Loss: 2 psig <Insert value.>
   d. Replacement Pressure Loss: 6 psig <Insert value.>

10. Electrical Characteristics (Single-Point Connection):
    a. Volts: <Insert value.>
    b. Phase: <Insert value.>
    c. Hertz: <Insert value.>
    d. Full-Load Amperes: <Insert value.>
    e. Minimum Circuit Ampacity: <Insert value.>
    f. Maximum Overcurrent Protection: <Insert amperage.>
    g. Interrupting Capacity: <Insert amperage.>
2.11 FILTRATION EQUIPMENT

A. Multimedia Filters:
   1. Description: Factory-fabricated and -tested, simplex, multimedia filter system of filter tank, media, strainer, circulating pump, piping, and controls for removing particles from water.
   2. General
      a. Provide 10 micron particle removal at CU campus. Coordinate w/ facilities office.
      b. Scope:

         1) This section specifies a High Efficiency Sand Filtration System rated for 0.5 micron particle removal for the cooling system described below:

         a) Design Condenser Circulation Rate: ———GPM
         b) Design Temperature Drop Across Tower: ——— Deg F
         c) Cycles of concentration: ———, location ———

         2)

   3. Operating Requirements:

      a. Filter shall operate continuously removing suspended particles from the tower water until either a pressure drop across filter bed of 18 PSI is reached or twenty-four hours has elapsed. At either point filter shall automatically backwash for 5 minutes on each vessel sequentially. After backwash cycle, filter shall automatically return to filtration mode.
      b. To conserve water and minimize load to floor drain, maximum backwash flow rate shall be 10 GPM per square foot of filter surface area.
      c. Backwash Source: City or Condenser Water
      d. Filter shall be capable of field adjustment to utilize either City Water or Tower Water as the backwash source.

   4. Filtration System Sizing:
a. It shall be the responsibility of the filter manufacturer to size the filtration system, based on their published literature, to meet the specification and performance criteria. The selection and sizing of the filtration system shall be based on the circulation rate and temperature drop across the tower. Filter system sizing shall also consider both local air quality and water chemistry.

5. Quality Assurance:

a. Filter shall be designed to provide 0.5 micron filtration by utilizing ultrafine sand with an effective size of not more than 0.16 millimeters.
b. Filter design flow rate shall be greater than 20 GPM per square foot of surface area.
c. Filter shall be sized to remove at least 50% (by count) of the 0.5 micron particles and at least 80% (by count) of the 2 micron particles typically found in cooling water, within 30 days of startup.

6. Filter system shall be rated for 75 PSIG inlet pressure to filter pump.

7. Tanks shall be #304L Stainless Steel rated for 125 PSIG operating pressure.

8. Manifold shall be Type L copper.
   a. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed joints.

9. System shall be factory assembled and tested for rated pressure and control functions.

10. Submittals:

   a. Submit shop drawings and product data as follows:

      1) Submit shop drawings indicating system schematics, equipment locations, and component locations.
      2) Submit manufacturer's installation instructions.
      3) If alternate product is submitted, provide Particle Distribution Analysis results from at least three previous users where the criteria described in Quality Assurance section is met. Include tower tonnage, tower water circulation rate, temperature drop across the tower, and filtration rate. Note % of tower water circulation rate being filtered in each case. Include facility name, address, contacts and phone numbers.

11. Operation and Maintenance Data:

   a. Submit operation and maintenance data in a binder.
12. Acceptable Products:
   a. AmeriWater High Efficiency CW-series 0.5 Micron Sand Filter.
   b. Diamond filter – High efficiency filter. 0.5 Micron Sand Filter
   c. Vortisand High efficiency filter. 0.5 Micron Sand Filter

13. General Construction Requirements:
   a. Filter shall be comprised of #304L Stainless Steel vessel(s) with Type L copper manifold and cast iron circulating pump. The backwash shall be adjustable on the field for either city water or system water. The filter shall be mounted on a Stainless Steel skid.
   b. Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

14. Components:
   a. Natural quartz media shall meet AWWA B-100, ANSI, and NSF-61 standards for consistently uniform and chemically inert filter media. Crushed or ground media is not acceptable.
   b. Valves shall be JC two-piece bronze ball type with multi-piece packing set, blowout proof stem design, adjustable packing gland, stainless ball and stem, RPTFE seat. Valves shall be actuated with individual 24V electric motors on each valve.
   c. Filter shall be equipped with two pressure gauges. The gauges shall be anti-flutter and shall have a stainless steel casing, with brass internals. The minimum face size shall be no less than 2-1/2". One gauge marked (IN) shall be connected to the filter pump discharge and the second gauge marked (OUT) shall be connected to the outlet side of the filter.
   d. Top inlet distributor shall be 304 stainless steel. Under drain shall be 316 stainless steel wedgewire screen pipe.
   e. Backwash flow control shall be rated for full backwash flow from 25 PSIG to 120 PSIG.
   f. Filter pump shall be cast iron, close coupled with mechanical seal. Pump motor to be TEFC with a service factor of not less than 1.15.
   g. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

1) Casing: Radially split, cast iron.
2) Pressure Rating: 125 psig minimum.
3) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
4) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
5) Seal: Mechanical.
6) Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

h. Filter control shall be mounted in a NEMA 4X enclosure and shall contain the following:

1) An Allen Bradley 1200 Series PLC
2) An Allen Bradley motor starter and service disconnect.
3) A step-down transformer to convert 3phase power to 115 VAC to operate control components and convert 115 VAC to 24V for valve actuation.
4) A pressure differential switch factory set to initiate backwash at 18 PSI differential across the filter bed.
5) A manual backwash switch, of a momentary contact design, mounted on the outside of the control panel door.
6) A backwash indicating light, pump status light and pump on/off switch mounted on the outside of the control panel door.
7) A non-resettable backwash counter mounted on the outside of the control panel door to indicate the number of times the filter has backwashed.
8) PLC shall be programmed to control valve actuation, duration of the backwash cycle, and pump on/off. Backwash shall be initiated by the 24-hour timer, pressure differential switch, or manual backwash button. An internal delay of no less than 15 seconds shall be built into the program timer to avoid false backwashing.
9) PLC shall also include a set of dry contacts that can be connected to the BMS to monitor backwash frequency.

15. Installation:

a. Place vessels as shown in installation drawing and level. Use manifold as guide for spacing.
b. Install upper and lower manifolds as per manufacturer’s instructions.
c. Install piping between manifold and pump(s) if necessary.
d. Attach control panel to vessel mount.
e. Connect control wiring to valves.
f. Connect electrical power to control panel and control to pump(s) according to local electrical codes and wiring diagram supplied by manufacturer.

g. Install media according to manufacturer’s instructions.

16. Startup & Testing:
   a. Startup by factory authorized agent shall be provided.
   b. Submit cooling water particle analysis reports showing count and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 2, 2 to 5, 5 to 10, 10 to 20, and 20 and larger at time of startup.
   c. Submit cooling water particle analysis reports showing count and volume of particles within the following micron size ranges: 0.5 to 1, 1 to 2, 2 to 5, 5 to 10, 10 to 20, and 20 and larger 30 days after startup.
   d. Submit report analyzing results from testing and confirming that system meets performance specifications in paragraph above.

17. Capacities and Characteristics:
   a. Filter Design:
      2) Clean Pressure Loss: 5 psig <Insert value>.
      3) Maximum Media Flow Rate: 15 gpm/sq. ft. <Insert value>.
      4) Filtration Efficiency: 98 <Insert number> percent.
      5) Particle Specific Gravity: 1.8 <Insert number>.
      6) Particle Size: 5 10 20 45 <Insert number> microns.
   b. Filter Tank: With internal distribution piping.
      1) Pressure Rating: <Insert psig>.
      2) Diameter: <Insert inches>.
      3) Inlet and Outlet Size: <Insert NPS>.
      4) Blowdown Piping Outlet Size: <Insert NPS>.
   c. Filter Media: <Insert material>.
   d. Start Backwash Pressure Loss: 13 psig <Insert value>.
   e. Backwash Period: 10 <Insert number> minutes.
   f. Circulating Pump:
      1) Capacity: <Insert gpm>.
      2) Total Dynamic Head: <Insert feet>.
      3) Motor Speed: <Insert number> rpm.
4) Inlet Size: <Insert NPS.>  
5) Outlet Size: <Insert NPS.>

g. Pump Motor Size and Electrical Characteristics:

1) Horsepower: <Insert value.>  
2) Volts: 120 208 240 277 480 <Insert number> V.  
3) Phase: Single Three.  
4) Hertz: 60 <Insert number> Hz.

h. Unit Electrical Characteristics:

1) Full-Load Amperes: <Insert value.>  
2) Minimum Circuit Ampacity: <Insert value.>  
3) Maximum Overcurrent Protection: <Insert amperage.>  
4) Interrupting Capacity: <Insert amperage.>

B. Self-Cleaning Strainers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

   a. Everfilt.  
   b. Hayward Industrial Products, Inc.  
   c. Islip Flow Controls Inc.  
   d. Orival, Inc.  
   e. Sure Flow Equipment, Inc.

4. Description: Factory-fabricated and -tested, ASTM A 126, Class B, cast-iron or steel, self-cleaning strainer system of tank, strainer, backwash arm or cleaning spiral, drive and motor, piping, and controls for removing particles from water.

   a. Fabricate and label ASTM A 126, Class B, cast-iron or steel strainer tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
b. Pipe Connections:

1) NPS 2 and Smaller: Threaded according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.

5. Motorized Valves: Flanged or grooved-end, ductile-iron angle type with EPDM <Insert material> valve seat and stem seal; with ASTM B 148 aluminum bronze disc.


7. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.


9. Backwash Arm Drive:

a. Drive Casing: Cast iron.
b. Worm Gears: Immersed in oil.
c. Motor: ODP motor supported on the strainer-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

10. Controls: Automatic control of backwash; factory wired for single electrical connection.

a. Panel: NEMA 250, Type 4 enclosure with time clock and pressure gages.
c. Backwash: Automatic; with time clock and differential pressure switch.
d. Backwash Valve: Electric actuator.

11. Support: Skid mounting. Fabricate supports and base and attachment to tank with reinforcement strong enough to resist strainer movement during a seismic event when strainer base is anchored to building structure.

12. Capacities and Characteristics:

a. Strainer Design:

2) Clean Pressure Loss: 5 psig <Insert value.>
3) Strainer Mesh: 40 60 80 <Insert number.>
b. Strainer Tank: With internal distribution piping.
   1) Material: Cast iron Steel <Insert material>.
   2) Pressure Rating: 150 psig <Insert value>.
   3) Inlet and Outlet Size: <Insert NPS>.
   4) Backwash Piping Outlet Size: <Insert NPS>.

c. Start Backwash: 10 psig <Insert value>.

d. Backwash Period: 5 <Insert number> minutes.

e. Drive Motor Size and Electrical Characteristics:
   1) Horsepower: <Insert value>.
   2) Volts: 120 208 240 277 480 <Insert number> V.
   3) Phase: Single Three.
   4) Hertz: 60 <Insert number> Hz.

f. Unit Electrical Characteristics:
   1) Full-Load Amperes: <Insert value>.
   2) Minimum Circuit Ampacity: <Insert value>.
   3) Maximum Overcurrent Protection: <Insert amperage>.
   4) Interrupting Capacity: <Insert amperage>.

C. Cartridge-Type Filters:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
      a. Cycron Corporation.
      c. Filter Specialists, Inc.
      e. Hayward Industrial Products, Inc.
      g. Parker Hannifin Corp.; Process Filtration Div.
4. Description: Floor-mounting housing with filter cartridges for removing particles from water.

   a. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through cartridge-type water filter; with base, feet, or skirt.

      1) Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
      2) Steel Housing Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
      3) Plastic Housing Pipe Connections NPS 2-1/2 and Larger: 150-psig plastic flanges.

   b. Cartridge: Replaceable; of shape to fit housing.

5. Capacities and Characteristics:

   a. Filter Design:

      1) Water Flow Rate: &lt;Insert gpm.&gt;
      2) Filtration Efficiency: 98 &lt;Insert number&gt; percent.
      3) Particle Size: 10-20 &lt;Insert number&gt; microns and larger.
      4) Clean Pressure Loss: 2 psig
      5) Pressure Loss at Replacement: 6 psig

   b. Housing:

      2) Pressure Rating: &lt;Insert psig.&gt;
      3) Seal Material: NBR &lt;Insert material&gt;.
      4) Diameter: &lt;Insert inches.&gt;
5) Height or Length: <Insert inches.>
6) Inlet and Outlet Size: <Insert NPS.>
7) Drain Size: Not applicable <Insert NPS.>
8) Bag Support Basket Material: Stainless steel <Insert material.>

c. Bag Cartridge:
   1) Number Required: <Insert number.>
   2) Nominal Diameter: <Insert inches.>
   3) Nominal Length: <Insert inches.>
   4) Media Material: Cotton Polyester Polypropylene <Insert material.>

D. Centrifugal Separators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Alamo Water Treatment; Ecodyne Water Treatment, Inc.
      b. Culligan International.
      c. Griswold Controls.
      d. LAKOS; a div. of Claude Laval Corporation.
      e. PEP Filters, Inc.
      f. Puroflux Corporation.
      g. Rosedale Products, Inc.
      h. USFilter.
   2. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
   3. Housing: With manufacturer’s proprietary system of baffles and chambers.
      a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.
      c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
      d. Collection Chamber: Designed to hold separated particles.
      e. Outlet: Near top of unit.
      f. Purge: At bottom of collection chamber.
      g. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
h. Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.

4. Motorized Purge Valve: Gate or plug pattern valve.
   a. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.

5. Strainer: Stainless-steel basket type mounted on pump suction.

6. Piping: ASTM A 53/A 53M, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.

7. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.

8. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
   a. Casing: Radially split, cast iron.
   b. Pressure Rating: 125 psig minimum.
   c. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   e. Seal: Mechanical.
   f. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

9. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.
   a. Panel: NEMA 250, Type 4 enclosure.
   d. TDS Controller Interlock: Open separator purge valve with bleed-off control.

10. Support: Skid mounting. Fabricate supports and base and attachment to separator housing with reinforcement strong enough to resist separator movement during a seismic event when separator base is anchored to building structure.
11. Capacities and Characteristics:

a. Separator Design:

1) Water Flow Rate: <Insert gpm.>
2) Pressure Loss: 5 psig
3) Separator Efficiency: 98 percent.
4) Particle Specific Gravity: 1.8
5) Particle Size: 5 <Insert number> microns.

b. Housing:

1) Material: Steel Stainless steel Plastic Fiberglass <Insert material>.
2) Pressure Rating: <Insert psig.>
3) Diameter: <Insert inches.>
4) Height: <Insert inches.>
5) Inlet and Outlet Size: <Insert NPS.>
6) Purge Size: <Insert NPS.>

c. Circulating Pump:

1) Capacity: <Insert gpm.>
2) Total Dynamic Head: <Insert feet.>
3) Motor Speed: <Insert number> rpm.
4) Inlet Size: <Insert NPS.>
5) Outlet Size: <Insert NPS.>

d. Pump Motor Size and Electrical Characteristics:

1) Horsepower: Insert value.>
2) Volts: 120 208 240 277 480 <Insert number> V.
3) Phase: Single Three.
4) Hertz: 60 <Insert number> Hz.
5) Full-Load Amperes: <Insert value.>
6) Minimum Circuit Ampacity: <Insert value.>
7) Maximum Overcurrent Protection: <Insert amperage.>
8) Interrupting Capacity: <Insert amperage.>
2.12 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating chilled water dual-temperature water and glycol cooling, shall have the following water qualities:

1. pH: Maintain a value within 8.0 to 10.3.
2. Soluble Copper: Maintain a maximum value of 0.10 ppm.
3. TDS: Maintain a maximum value Do not exceed 4,000 mhos.
4. Ammonia: Maintain a maximum value of less than 2.0 ppm.
5. Microbiological Limits:
   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 cells/ml.
   b. Total Anaerobic Plate Count: Maintain a maximum value of 50 cells/ml.
   c. Nitrate Reducers: Maintain a maximum value of 50 cells/ml.
   d. Sulfate Reducers: Maintain a maximum value of 50 cells/ml.
   e. Iron Bacteria: Maintain a maximum value of 50 cells/ml.

D. Steam Boiler and Steam Condensate:

1. Steam Condensate:
   a. pH: Maintain a value within 8.0 to 9.5
   b. Soluble Copper: Maintain a maximum value of 0.10 ppm.
   c. TDS: Maintain a maximum value of 10 ppm, Feedwater quality dependent.
   d. Total Hardness: Maintain a maximum value of 1.0 ppm.
   e. Amines within FDA limits.

2. Steam boiler operating at 15 psig and less shall have the following water qualities:
   a. "OH" Alkalinity: Maintain a value within 200 to 400 ppm.
   b. TDS: Maintain a value within 600 to 3000 ppm.
   c. Feedwater requirements in accordance with ASME.
3. Steam boiler operating at more than 15 psig shall have the following water qualities:
   a. "OH" Alkalinity: 200 to 400 ppm.
   b. TDS: Maintain a value within 600 to 1200 ppm to maximum 30 times RO water TDS.

E. Open hydronic systems, including condenser fluid-cooler spray water, shall have the following water qualities:
   1. Soluble Copper: Maintain a maximum value of 0.5 ppm of cycles.
   2. TDS: Maintain a maximum value of 10 ppm, depends upon LSI.
   3. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 50 cells /ml or less
      c. Nitrate Reducers: Maintain a maximum value of 50 cells /ml or less
      d. Sulfate Reducers: Maintain a maximum value of 50 cells /ml or less
      e. Iron Bacteria: Maintain a maximum value of 50 cells /ml or less
      f. Polymer Testable: Maintain a minimum value within 5+ ppm

F. Passivation for Galvanized Steel: For the first 60 days of operation.
   1. pH: Maintain a value within 7 to 8.
   2. Calcium Carbonate Hardness: Maintain a value within 50 ppm.

2.13 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2.14 TREATMENT

A. Provide treatment for systems as follows:
1. Condenser water system treatment shall be as follows:

a. Molybdate zinc phosphonate & polymers or other chromate free corrosion inhibitor approved by consulting engineers.
   
   1) Liquid form shall be suitable for pumping directly from 65 gallon storage tanks into condenser water system and shall be supplied in five gallon containers.
   
   2) Polymers blended with corrosion inhibitors shall be anionic, specifically designed for stabilizing zinc, irons and phosphates in alkaline environment. Dispersant shall be blended with the corrosion inhibitors to keep system clean.

b. Biocides shall be two different types of treatment for alternating applications and shall be EPA registered for use in recirculating cooling water system. Compounds or mercury, copper or arsenic and oxidizers will not be permitted. Treatment shall be in accordance with EPA approved label.

c. Blowdown shall be controlled automatically by water conductivity. Maintain maximum cycles of concentration in water 10 times concentration in make-up. For rate, refer to Treatment schedule at end of this section.

d. Preliminary work required, includes, but is not limited to:
   
   1) Refer to the drawing for additional information and clarification
   
   2) Provide a training manual to include operating and maintenance procedures on equipment, chemical control limits, material safety data sheets, lay-up and start-up procedures.
   
   3) All steps in the following treatment procedures must be accomplished in immediate succession with no delay. Provide overtime manpower to accomplish same.
   
   4) Leave all valve trains in place and open for cleaning and treatment procedures and hydrostatic testing.
   
   5) Install drain outlets at deadends, low points and heat exchangers.
6) Insert temporary wire screens of 140 microns or 9/64 inch perforations at heat exchanger inlets.

7) Remove all corrosion coupons and sensors from water treatment piping.

e. Preliminary cleaning procedures:

1) Remove all extraneous loose debris, construction material, trash and dirt from piping, filters and all equipment. Remove as much dry material as possible, for this material prevents protective coating transfer to hard to reach portions of the system.

2) Flush water fill line separately to drain. If a new water line has been installed, be sure that rust and debris from it is not washed into the system.

3) Fill the system piping and equipment with water and recirculate for one with the temporary bypasses at open positions.

4) Turn on direct make-up and begin blowing down deadends, low points and y-strainers until water runs “city-water clean” as fast as make-up will allow.

5) Remove all screens and strainers, clean and replace. Flush all temporary bypasses.

6) Add alkaline, non-foaming, non-chlorinated detergent disinfectant plus non-foaming wetting agent to remove cutting oil, excess pipe joint compound, fine solids and other materials at a dosage of 5 lbs per 100 gallons of system water.

7) Recirculate for 4 to 8 hours.

8) Turn on direct make-up and begin flushing all drain outlets, y-strainers, dead ends and bypasses until water meets the following parameters: Iron levels within 1 ppm, conductivity within 10 mmhs, orthophosphate within 1 ppm and turbidity within 1 FTU.

9) Isolate tower basins to carry out vacuuming and power spray washing of tower interior. Immediately begin the “pretreatment procedure”.

f. Pretreatment procedure:
1) Fill the system piping and equipment with water while adding non-foaming, water-based lay-up inhibitors to protect the piping as per chemical manufacturer’s recommended dosage.

2) Recirculate for 2 hours. All heat exchangers and condensers must be offline and with no heat load.

3) Stop the pumps and secure the system for hydrostatic tests.

4) If the hydrostatic test fails, refill the system and begin pretreatment procedures again from step “g”.

5) After successful completion of the hydrostatic test, disconnect all apparatus and secure the system for the resumption of the pretreatment procedure.

6) Begin flushing systems as fast as make-up will allow. Continue until water is “city water clean”.

7) Remove all screens, strainers and temporary bypasses. Clean and replace screens and strainers immediately and begin the “passivation procedure”.

g. Passivation Procedure

1) Fill the system piping and equipment with water while adding molybdate/silicate at an amount of 0.5 gallon to 100 gallons of system water.

2) Install corrosion coupons and water test sensors at the water treatment station. Recirculate water for 24-72 hours.

3) Begin flushing systems as fast as make-up will allow. Continue until water conductivity is below 200 micro-Siemens/cm.

4) Begin “initial condenser water system treatment” immediately.

h. Initial Condenser Water System Treatment

1) Install corrosion coupons and 5 micron, high-efficiency filter bag in the side-stream filter.
2) Test water for corrosion inhibitor level. Add corrosion inhibitor if necessary to restore the regular control range.

3) Add biocide per water treatment contractor’s recommended dosage.

4) Record make-up water meter reading.

i. Condenser Water Maintenance

1) Dose system with corrosion and scale inhibitor. Add the inhibitor as required to meet specified concentrations. The maintenance dosing shall be controlled with an electronic controller based on makeup water meter signals. The inhibitor shall protect steel and copper at the rate of less than 2 mils per year and 0.2 mils per year, respectively.

2) Dose system with biocides weekly on alternate manner. They shall maintain the planktonic total bacterial level below 100,000 colonies per ml with no presence of sulfate reducing and iron bacteria. The dosing shall be controlled with an electronic controller.

3) Generate data logging reports weekly with the electronic controller on pH, conductivity, water usage, corrosion rates, alarm and chemical storage tank levels.

2. Chilled water and hot water systems, treatment shall be as follows:

a. For pH range, refer to Treatment Schedule at end of this section.

b. Mixture of Molybdate, Silicate, Polymeric dispersant and Tolytriazole or equivalent non-ferrous inhibitor, maintaining minimum concentration as noted in Treatment schedule at end of this section. The inhibitor shall maintain corrosion of steel and copper below 2 mils per year and 0.2 mils per year respectively.

c. Non-oxidizing, non-acidic and non-cationic biocide, glutaraldehyde or approved equal, to control total bacteria count below 1000 colonies per ml.

d. Preliminary work required, but is not limited to:

1) Refer to the drawing for additional information and clarification
2) Provide a training manual to include operating and maintenance procedures on equipment, chemical control limits, material safety data sheets, lay-up and start-up procedures.

3) All steps in the following cleaning and treatment procedures must be accomplished in immediate succession with no delay. Provide overtime manpower to accomplish same.

4) Leave all valve trains in place and open for cleaning and treatment procedures and hydrostatic testing.

5) Install drain outlets at dead ends, low points and heat exchangers.

6) Insert temporary wire screens of 140 microns or 9/64 inch perforations at chiller inlets. Use a 50 micron bag in the side-stream bag filter.

e. Preliminary cleaning procedures:

1) Remove all extraneous loose debris, construction material, trash and dirt from piping, filters and all equipment. Remove as much dry material as possible, for this material prevents protective coating transfer to hard to reach portions of the system.

2) Flush water fill line separately to drain. If a new water line has been installed, be sure that rust and debris from it is not washed into the system.

3) Fill the system piping and equipment with water and recirculate for one with the temporary bypasses at open positions.

4) Turn on direct make-up and begin blowing down deadends, low points and y-strainers until water runs “city-water clean” as fast as make-up will allow.

5) Remove all screens and strainers, clean and replace. Flush all temporary bypasses.

6) Add alkaline, non-foaming, non-chlorinated detergent disinfectant plus non-foaming wetting agent to remove cutting oil, excess pipe joint compound, fine solids and other materials at a dosage of 5 lbs per 100 gallons of system water.
7) Recirculate for 4 to 8 hours.

8) Turn on direct make-up and begin flushing all drain outlets, y-strainers, dead ends and bypasses until water meets the following parameters: Iron levels within 1 ppm, conductivity within 10 mmhs, orthophosphate within 1 ppm and turbidity within 1 FTU.

9) Isolate tower basins to carry out vacuuming and power spray washing of tower interior. Immediately begin the "pretreatment procedure".

f. Pretreatment procedure:

1) Fill the system piping and equipment with water while adding non-foaming, water-based lay-up inhibitors to protect the piping as per chemical manufacturer’s recommended dosage.

2) Recirculate for 2 hours. All heat exchangers and condensers must be off-line and with no heat load.

3) Stop the pumps and secure the system for hydrostatic tests.

4) If the hydrostatic test fails, refill the system and begin pretreatment procedures again from step “g”.

5) After successful completion of the hydrostatic test, disconnect all apparatus and secure the system for the resumption of the pretreatment procedure.

6) Begin flushing systems as fast as make-up will allow. Continue until water is “city water clean”.

7) Remove all screens, strainers and temporary bypasses. Clean and replace screens and strainers immediately and begin the “passivation procedure”.

g. Passivation Procedure

1) Fill the system piping and equipment with water while adding TWICE the regular amount of the maintenance corrosion inhibitor into the water.

2) Recirculate for 24-72 hours.
3) Change the filter bag to a 10 micron high efficiency bag.

4) Keep pressure differential across the bag filter less than 15 psig by washing or replacing the filter bag.

h. Initial chilled water and hot water system treatment:

1) Install corrosion coupons and 5 micron, high-efficiency filter bag in the sidestream filter.

2) Test water for corrosion inhibitor level. Add corrosion inhibitor if necessary to restore the regular control range.

3) Add biocide per water treatment contractor’s recommended dosage.

4) Record make-up water meter reading.

i. Chilled water and hot water maintenance:

1) Dose system with corrosion inhibitor based on test results and water meter readings.

2) Remove corrosion coupons on a quarterly basis.

3) Change the filter bags on pressure differential and flow meter readings.

4) Test water monthly for pH, alkalinity, ammonia, hardness, molybdates, silicates, iron, copper, conductivity, total bacteria, turbidity, iron bacteria and sulfur reducing bacteria.

3. Glycol (chilled, condenser or hot water) systems shall be treated as such:

a. For pH range, refer to treatment schedule at the end of this section.

b. Mixture of phosphates, polymeric dispersant and tolytriazole or equivalent non-ferrous inhibitor with 40% propylene glycol, premixed with deionized water. The inhibitor shall maintain corrosion of steel and copper below 2 mils per year and 0.2 mils per year respectively.

c. Preliminary work required, but is not limited to:
1) Refer to the drawing for additional information and clarification

2) Provide a training manual to include operating and maintenance procedures on equipment, chemical control limits, material safety data sheets, lay-up and start-up procedures.

3) All steps in the following treatment procedures must be accomplished in immediate succession with no delay. Provide overtime manpower to accomplish same.

4) Leave all valve trains in place and open for cleaning and treatment procedures and hydrostatic testing.

5) Install drain outlets at dead ends, low points and chillers.

6) Insert temporary bypasses at heat exchangers. Use a 50 micron bag in the side-stream bag filter.

d. Preliminary cleaning procedures:

1) Remove all extraneous loose debris, construction material, trash and dirt from piping, filters and all equipment. Remove as much dry material as possible, for this material prevents protective coating transfer to hard to reach portions of the system.

2) Flush water fill line separately to drain. If a new water line has been installed, be sure that rust and debris from it is not washed into the system.

3) Fill the system piping and equipment with water and recirculate for one with the temporary bypasses at open positions.

4) Turn on direct make-up and begin blowing down deadends, low points and y-strainers until water runs “city-water clean” as fast as make-up will allow.

5) Remove all screens and strainers, clean and replace. Flush all temporary bypasses.

6) Add alkaline, non-foaming, non-chlorinated detergent disinfectant plus non-foaming wetting agent to remove cutting oil, excess pipe joint
compound, fine solids and other materials at a dosage of 5 lbs per 100 gallons of system water.

7) Recirculate for 4 to 8 hours.

8) Turn on direct make-up and begin flushing all drain outlets, y-strainers, dead ends and bypasses until water meets the following parameters: Iron levels within 1 ppm, conductivity within 10 mmhos, orthophosphate within 1 ppm and turbidity within 1 FTU.

9) Isolate tower basins to carry out vacuuming and power spray washing of tower interior. Immediately begin the “pretreatment procedure”.

e. Pretreatment procedure:

1) Fill the system piping and equipment with water while adding non-foaming, water-based lay-up inhibitors to protect the piping as per chemical manufacturer’s recommended dosage.

2) Recirculate for 2 hours. All heat exchangers and condensers must be off-line and with no heat load.

3) Stop the pumps and secure the system for hydrostatic tests.

4) If the hydrostatic test fails, refill the system and begin pretreatment procedures again from step “g”.

5) After successful completion of the hydrostatic test, disconnect all apparatus and secure the system for the resumption of the pretreatment procedure.

6) Begin flushing systems as fast as make-up will allow. Continue until water is “city water clean”.

7) Remove all screens, strainers and temporary bypasses. Clean and replace screens and strainers immediately and begin the “passivation procedure”.

f. Passivation Procedure

1) Fill the system piping and equipment with water while adding TWICE the regular amount of the maintenance corrosion inhibitor into the water.
2) Recirculate for 24-72 hours.

3) Change the filter bag to a 10 micron high efficiency bag.

4) Keep pressure differential across the bag filter less than 1.5 psig by washing or replacing the filter bag.

5) Purge all residual solution with clean compressed air or nitrogen.

g. Initial glycol water system treatment:

1) Install corrosion coupons and 5 micron, high-efficiency filter bag in the side stream filter.

2) Fill system with inhibited propylene glycol solution from ground level to purge air at high points.

3) Test water for corrosion inhibitor and glycol levels. Add corrosion inhibitor/glycol if necessary to restore the regular control range.

4) Record make-up water meter reading.

h. Glycol water maintenance:

1) Dose system with inhibited glycol based on test results and system pressure.

2) Prohibit adding city water to the system.

3) Change the filter bags on pressure differential and flow meter readings.

4) Test water monthly for pH, alkalinity, ammonia, hardness, phosphates, iron, copper, conductivity, turbidity, freezing point, propylene glycol and azoles.

i. Examine corrosion coupons on quarterly basis to report weight gain and weight loss.

4. Steam, steam condensate and boiler feed water systems.

a. Preliminary work required includes, but is not limited to:
1) All steps in the following treatment procedures must be accomplished in immediate succession with no delay. Provide overtime manpower to accomplish same.

2) Install shut off ball valves at the horizontal headers for a temporary connection with hoses, recirculating pumps and tanks.

3) Install vent and drain outlets at the temporary piping.

4) Clean the piping with aqueous cleaning solutions first, followed with steam blowout.

b. Cleaning procedure:

1) Remove all lose mill scale with circulation of plain city water at 3 ft per second or higher (300 gpm in the riser) for 15 minutes.

2) Add a liquid alkaline inhibited chelate cleaner into the piping to create a 5% cleaning solution to remove old mill scale and rust.

3) Cleaner shall contain erythorbate as a corrosion inhibitor, sodium gluconate and EDTA as chelates, non-foaming wetting agent and low molecular weight polymeric dispersant.

4) Circulate cleaner for 4 to 8 hours. Test for residual chelate and corrosion inhibitor levels during circulation. Add additional cleaner if necessary to maintain he strength of the cleaner AT 5% and 200 ppm of erythorbate.

5) Drain and flush the loop with city water until it meets the following parameters: Iron levels within 1 ppm, conductivity within 10 mmhs, orthophosphate within 1 ppm and turbidity within 1 FTU.

5. Passivation procedure:

a. Fill the temporary piping with water while adding alkaline silicate based passivator at an amount of half a gallon to 100 gallons.

b. Recirculate the piping for 24 to 48 hours.

c. Drain piping and begin cleaning new pipes with steam.
6. Boiler feed water treatment
   a. A liquid sodium sulfite, polyacrylate, caustic formulation shall be added to the
      boiler feed water (storage section of the Deaerator or feed water tank) to
      achieve a sulfite residual of 2-3 ppm sulfite and a pH of 8-9.

7. Humidifiers:
   a. Spray coil and pan types:
      1) See treatment schedule at the end of the section for corrosion/scale
         inhibitor and organic dispersant.
      2) For pH range, refer to the treatment schedule at the end of this section.
      3) Biocides: if significant slime is detected after operation, provide two
         different types of treatment for alternating application. Treatment shall be
         EPA registered for use in air-washers or humidifiers and shall be non-
         volatile and odorless. Compounds of mercury, copper and arsenic will
         not be permitted. Treatment should be in accordance with EPA approved
         label.
      4) For external treatment with demineralized and UV sterilizers: See
         Equipment.

8. Steam boiler system:
   a. Makeup water shall be softened and demineralized.
   b. Feed water shall be deaerated. Oxygen scavenger shall be added to the
      deaerator storage section.
   c. Boiling water: for initial fill, add catalyzed sodium sulfite at minimum rate of 1
      lb per 1000 gallons of water to provide corrosion protection. Add sodium
      phosphate-polymer or sodium phosphate-chelant and sodium sulfite (if no
      deaerator). Provide blow-down at surface and bottom (mud drum).
   d. Condensate: Add volatile neutralizing amine and filming amine.
2.15 FIELD QUALITY CONTROL

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
   4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
   7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
   8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at four-week
intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. At four week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part I "Performance Requirements" Article.

G. Comply with ASTM D 3370 and with the following standards:

METAL DUCTS
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
4. Double-wall round and flat-oval ducts and fittings.
5. Sheet metal materials.
7. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 QUALITY ASSURANCE


B. NFPA Compliance:

2. NFPA 90B, “Installation of Warm Air Heating and Air Conditioning Systems.”

D. Indicate compliance with USGBC LEED rating criteria for Indoor environmental quality (IEQ).

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings (CAD Generated and Drawn to 3/8 scale):

1. Sheet metal shop standards shall be compiled directly from the “SMACNA DUCT CONSTRUCTION STANDARDS- Metal and Flexible” manual. Modifications for a specific project, if any, shall be indicated directly on the SMACNA templates. Modified shop standards not taken directly from the SMACNA templates will not be accepted. Any deviations from SMACNA shall be noted.
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Factory- and shop-fabricated ducts and fittings.
4. Duct layout (double line) indicating sizes, transitions, configuration, liner material, and static-pressure classes.
5. Elevation of top of ducts.
6. Dimensions of main duct runs from building grid lines.
7. Sheet metal thicknesses
8. Fittings.
9. Reinforcement details and spacing.
10. Seam and joint construction and sealing
11. Materials, fabrication, assembly, and spacing of hangers and supports.
12. Penetrations through fire-rated and other partitions.
13. Equipment installation based on equipment being used on Project.
14. Access clearance for all equipment and accessories
15. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
16. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Welding certificates.
D. Field quality-control and test reports.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS
A. The following are base bid manufacturers for factory sheet metal products:
   a. Lindab Inc.
   b. McGill AirFlow LLC.
   c. SEMCO Incorporated.
   d. Sheet Metal Connectors, Inc.
   e. Spiral Manufacturing Co., Inc.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS
A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", latest edition, based on indicated static-pressure class unless otherwise indicated.

B. The following fitting connections and duct construction gauges are NOT acceptable
   1. Drive slip T-1, T-2 fitting connections
   2. 26 gauge ductwork.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Fittings and/or joints of two different gauges, connected joint rating shall meet more stringent conditions
   1. Use the following SMACNA Transverse (Girth) Joints
      a. Duct construction as follows for 2" w.g. class:
         1) Up to 12” wide use T-6 or T-7
         2) 13” to 28” wide use T-11 or T12
         3) 29” wide and up use TDC or TDF
      b. Duct construction as follows for 3” w.g. class:
         1) Up to 20” wide use T-6 or T-7
         2) 21” to 24” wide use T-11 or T12

Metal Ducts
233113 - 3
3) 25" wide and up use TDC or TDF

**c. Duct construction as follows for 6" w.g. class:**

1) Up to 12" wide use T-6 or T-7
2) 13" to 18" wide use T-11 or T12
3) 19" wide and up use TDC or TDF

**D. Longitudinal Seams:** Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

**E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction:** Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

**A. Manufacturers:** Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. McGill AirFlow LLC.
2. Sheet Metal Connectors, Inc.

**B. Rectangular Ducts:** Fabricate ducts with indicated dimensions for the inner duct.

**C. The following fitting connections and duct construction gauges are NOT acceptable**

1. Drive slip T-1, T-2 fitting connections
2. 26 gauge ductwork

**D. Outer Duct:** Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

**E. Longitudinal Seams:** Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support
intervals, and other provisions in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: 1.5” thick (Indoor) and 2” thick (Outdoor) Flexible elastomeric duct liner complying with ASTM C534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F <Insert conductivity> at 75 deg F mean temperature.

G. Inner Duct: Minimum 0.028-inch solid sheet steel.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible."

1. Use the following SMACNA Transverse (Girth) Joints
   a. Duct construction as follows for 2” w.g. class:
      1) Up to 12” wide use T-6 or T-7
      2) 13” to 28” wide use T-11 or T12
      3) 29” wide and up use TDC or TDF
   b. Duct construction as follows for 3” w.g. class:
      1) Up to 20” wide use T-6 or T-7
      2) 21” to 24” wide use T-11 or T12
      3) 25” wide and up use TDC or TDF
   c. Duct construction as follows for 6” w.g. class:
      1) Up to 12” wide use T-6 or T-7
      2) 13” to 18” wide use T-11 or T12
      3) 19” wide and up use TDC or TDF

2.4 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS
A. General Fabrication Requirements: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
Metal Ducts

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Provide spiral seams for all ducts and fittings.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, 1995 edition, Figure 3-2, 2005 edition, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

F. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," 90 Degree Tees and Laterals," and "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.5 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.

B. Provide spiral seams for all ducts and fittings

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct) of the inner duct.

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," 90 Degree Tees and Laterals," and "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Inner Duct: Minimum 0.028-inch solid sheet steel.
F. Interstitial Insulation: 1.5” thick (Indoor) and 2” thick (Outdoor) Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2.6 Kitchen Ductwork

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following

B. Duraduct

   a. Kitchen range hood exhaust duct including fan discharge to atmosphere shall be provided as follows:
      1) Black carbon steel of following gauges and thicknesses. Inside building shall be in accordance with nyc code:
      2) Ducts with a cross-sectional area up to and including 155 square inches (100 000mm2) shall be constructed of 0.0598-inch (1.52 mm) no. 16 gage steel;
      3) Ducts with a cross-sectional area over 155 square inches (100 000 mm2), but not more than 200 square inches (0.129 m2) shall be constructed of 0.074-inch (1.9 mm) no. 14 gage steel; and
      4) Ducts with a cross-sectional area equal to or more than 200 square inches (0.129 m2) shall be constructed of 0.1046-inch (2.66 mm) no. 12 gage steel.
      5) If stainless steel is used for ducts of any of the cross-sectional areas shown above, the gage steel may be increased upwards (resulting in a smaller thickness) by 1 gage.
   b. Ducts installed outside or exposed to corrosive elements shall be constructed of stainless steel (minimum 18 gauge) to protect against corrosion as per NYC code. Provide all NYC code installation requirements.
   c. All seams, joints and penetrations shall be watertight continuous external arc welded, except where the duct stub collar of the hood is connected to the exhaust duct. Connection to the hood shall be continuous watertight external arc welded or in accordance with NFPA 96, 1984 or latest edition adopted by NYC.
d. Angle reinforcing shall be minimum 1-1/2 inch x 1-1/2 inch x 3/16 inch at maximum 4 ft on centers and in accordance with SMACNA Rectangular Industrial Duct Construction Standards shall be mounted.

2. Dishwasher Hood Exhaust Ducts:
   a. Type 304, stainless-steel sheet.
   b. Exposed to View: No. 4 finish.
   c. Concealed: No. 2D finish.
   d. Welded seams and flanged joints with watertight EPDM gaskets
   e. Watertight.

f. Wet exhausts duct from kitchen equipment shall be as follows:
   a. Stainless steel.

C.

2.7 SHEET METAL MATERIALS
A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", latest edition for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. EXPOSED DUCTWORK
1. Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections, including pittings, seam marks, stains, discolorations, and other imperfections. Provide finishes which will allow painting. Provide flat type seams and joints for all exposed duct construction

C. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

D. PVC-Coated, Galvanized Sheet Steel® Use for exhaust systems only) Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface.
Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

E. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

F. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

G. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

H. Factory- or Shop-Applied Antimicrobial Coating: (Use only for protective environment critical care applications)

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.

2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.

4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.


6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

I. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

J. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

K. Watertight construction where noted with edges bent 1/2 inch for watertight seal. Longitudinal seam sealant shall be similar to 3M Brand No. 800; Alcoa, aluminastic Type C, or solder. Stiffeners shall be plug or spot welded. Transverse joints shall be bolted
companion angles with 1/4 inch cadmium plated bolts with 6 inch minimum on centers and gasket.

L. Air tight construction where noted with longitudinal seams soldered. Stiffeners shall be plug or spot welded. Transverse joints shall be bolted companion angle with 1/4 inch cadmium plated bolts with 6 inch minimum on centers and gasket. Exposed, un-insulated ductwork shall be flush flat seam. Note: for exposed ductwork in finished areas where appearance is important. Check with architect and chief engineer before using.

M. Flush flat seam ductwork: Provide for all exposed uninsulated ducts and transverse joint detail shall be as indicated. Provide sheet metal 2 gauge numbers heavier than required for pressure classification with normal (standing) seam construction. Provide all joints and seams, smooth and aligned with no projections. For internal reinforcing, at transverse joints and on 2 ft centers, provide on ducts 31 inch to 60 inch wide, single vertical stay at duct midpoint, on ducts 61 inch to 90 inch wide provide 2 vertical stays on duct third (1/3) points and for ducts over 90 inch wide provide 3 vertical stays at ducts quarter (1/4) points. For vertical stays: provide 10 USSG galvanized steel, free of burrs and rough edges with both ends bent and fastened to top and bottom of duct.

N. Lead shielded ductwork: Provide lead shielded ductwork in and around x-ray room, as noted. Sheet lead in contact with concrete, mortar or plaster shall have surfaces coated with heavy bituminous or latex material. Joints shall be lapped minimum of 1 inch and soldered to form complete continuous seal. Provide shielding construction, materials and equipment in conformance with applicable requirements of National Bureau of Standards, handbook 60, Medical X-Ray Protection. Shielding shall be installed in such manner that X-ray absorption at any point is not less than above requirements or adjacent lead protection. Lead lining shall be securely installed, free waves, lumps or wrinkles and with as few joints as possible.

2.8 SEALANT AND GASKETS
A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Indicate compliance with USGBC LEED rating criteria for Indoor environmental quality (IEQ)

C. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

D. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

2. Type: S.
3. Grade: NS.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.
2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.


D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.10 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Ductmate Industries, Inc.
   3. Hilti Corp.
   5. Loos & Co.; Cableware Division.
   7. TOLCO; a brand of NIBCO INC.
   8. Unistrut Corporation; Tyco International, Ltd

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service the Office of Statewide Health Planning and Development for the State of California an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized and ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections and Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.11 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, latest edition" and performance requirements and design criteria indicated.

1. DESIGN
   STATIC PRESSURE

   PRESSURE CLASS

   2 IN. W.G

Metal Ducts
233113 - 14
6 IN. W.G.

10 IN. W.G.

a. Based on the following:

1) Single duct system: Static pressure at respective point in ductwork during normal operation.

2) Variable volume and dual duct systems: Static pressure at beginning of fan discharge duct.

b. Description of ductwork pressure class and equipment:

1) 6” and greater Duct Class: All supply ductwork from discharge of fans, air handling units, or AC units to inlets of terminal boxes on floor, all outdoor ductwork and all ductwork running through unconditioned spaces. Seal Class “A”, leakage class 6 (rectangular metal) or Class 3 (round)

2) 6” and greater Duct Class: All RETURN air ductwork from suction of fans, air handling units or AC units to inlets of terminal boxes on floor. Seal Class “A”, leakage class 6 (rectangular metal) or Class 3 (round)

3) 3” Duct Class: All suction and discharge of kitchen exhaust and other exhaust ductwork. Seal Class “B”, leakage class 12 *rectangular metal or Class 6 (round)

4) 2” Duct Class and less: All other low pressure ductwork. Seal Class “C”, leakage Class 24 (rectangular) or Class 12 (round).

5) Acoustic consultant requirement for 10 inch pressure class duct work for acoustic attenuation refer to Noise Control Section.

B. Flexible ductwork shall NOT be used on this project.
C. Structural Performance: Duct hangers supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SEI/ASCE 7.

2.12 QUALITY ASSURANCE

B. Welding Qualifications: Qualify procedures and personnel according to the following:


C. NFPA Compliance:
1. NFPA 90A, "Installation of Air conditioning and Ventilating Systems."

2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

D. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations, "Ch. 3 "Duct System," for range hood ducts, unless otherwise indicated.

E. Indicate compliance with USGBC LEED rating criteria for Indoor environmental quality (IEQ).

2.13 FIELD QUALITY CONTROL
A. Perform tests and inspections.

B. Leakage Tests:


2. All testing shall be done in the presence of the engineer or owner’s representative. The contractor is responsible for providing all collars, caps, electric power, etc. necessary to perform the tests. The contractor is also responsible for scheduling the test no less than three (3) business days prior to its intended occurrence. Low pressure ductwork (2” class) shall be tested on an as needed basis at the engineer’s direction. Leakage test procedure shall follow the outlines and classifications in the SMACNA HVAC duct
leakage test manual. If specimen fails to meet allotted leakage level, the contractor shall modify to bring it into compliance and shall retest it until acceptable leakage is demonstrated. Tests and necessary repair shall be completed prior to concealment of ducts.

3. Test the following systems:

   a. All ductwork greater than 2" class as defined within is to be tested.

4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

5. Test for leaks before insulation application.

6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

   1. Visually inspect duct system to ensure that no visible contaminants are present.

   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

       a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.14 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.

   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer’s written instructions after removal of surface deposits and debris.

END OF SECTION 233113
HVAC CASINGS
SECTION 233119 - HVAC CASINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shop-fabricated, field-assembled, double wall casings for HVAC equipment.

1.2 QUALITY ASSURANCE


B. Welding Qualifications: Qualify procedures and personnel according to the following:


1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of the following products:

1. Factory-fabricated casings.
2. Liners and adhesives.
3. Sealants and gaskets.

B. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.

1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Sheet metal thickness(es).
3. Reinforcement and spacing.
4. Seam and joint construction.
5. Access doors including frames, hinges, and latches.
6. Filter, coil, humidifier, and other apparatus being installed in and mounted on casing.
7. Locations for access to internal components.
8. Hangers and supports including methods for building attachment, vibration isolation, seismic restraints, and casing attachment.
9. Interior lighting, including switches.

C. Welding certificates.

D. Product Certificates: For acoustically critical casings, from manufacturer.
   1. Show sound-absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
   2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

E. Field quality-control reports.

F. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers for factory fabricated casings:
   1. IAC: Industrial Acoustics Corp.
   2. Vibro-Acoustics

2.2 GENERAL CASING FABRICATION REQUIREMENTS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 6, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Exterior Surface Galvanized Coating Designation: G90.
   2. Interior Surface Galvanized Coating Designation:
      a. Sections Not Exposed to Moisture: G90.
      b. Sections Housing and Downstream from Cooling Coil and Humidifiers: G90.

C. Stainless Steel: ASTM A 480/A 480M, Type 304 and Type 316, and having a No. 2D finish.

D. Factory- or Shop-Applied Antimicrobial Coating: (To be used for protective environment critical care applications)
   1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
   2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
   4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.
   5. Applied Coating Color: Standard

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.

G. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Provide shaft seals where fan shafts penetrate casing.
H. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-11, "Casing Access Doors - 2-inch wg," and Figure 6.12, "Casing Access Doors - 3-10-inch wg"; and according to pressure class of the plenum or casing section in which access doors are to be installed.

1. Size: 20 by 54 inches
3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
5. Neoprene gaskets around entire perimeters of door frames.
6. Doors shall open against air pressure.

I. Condensate Drain Pans: Formed sections of Type 304, stainless-steel sheet complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches past coil.

1. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
2. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
3. Insulation: Polystyrene or polyurethane.
4. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
5. Each drain pan connection shall have a trap. Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg. Include slab height in trap calculation.

2.3 SHOP-FABRICATED CASINGS

A. Single- and Double-Wall Casings: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

B. Double-Wall Casing Inner Panel: Solid sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
C. Interstitial Insulation: 2" thick Flexible-elastomeric duct liner complying with ASTM C 534, Type II for sheet materials and with NFPA 90A or NFPA 90B. Acoustic liner shall be protected with Tedlar/Mylar wrapping in case of perforated inner panel.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

D. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.

E. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use galvanized sheet steel of same thickness as casing and with a galvanized coating designation of G90.

F. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.

G. Reinforce casings with galvanized-steel angles.

2.4 MANUFACTURED CASINGS

A. Description: Double-wall, insulated, pressurized equipment casing.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following
1. IAC - Industrial Acoustics Corp.

C. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and solid perforated, galvanized sheet steel interior wall; with space between wall filled with insulation.

1. Wall Thickness: 2 inches 4 inches.
2. Fabricate with a minimum number of joints.
3. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
4. Sheet metal thickness shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.

D. Fill each panel assembly with 2” thick insulating material that is noncombustible, inert, mildew resistant and vermin proof and that complies with NFPA 90A. Acoustic liner shall be protected with Tedlar/Mylar wrapping in case of perforated inner panel.

1. Fabricate panels with continuous tongue-and-groove self-locking tongue-and-groove or self-locking joints effective inside and outside each panel.

E. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

2.5 CASING LINER

A. Flexible-Elastomeric Casing Liner: 2” thick Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1, and with NFPA 90A or NFPA 90B. Acoustic liner shall be protected with Tedlar/Mylar wrapping in case of inner perforated panel.

Manufacturers: Subject to compliance with requirements, provide products by one of the following

a. Aeroflex USA Inc.
b. Armacell LLC.
c. Rubatex International, LLC.

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- 0.135-inch- diameter shank,
length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-
steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, 
galvanized stainless steel, with beveled edge sized as required to hold insulation 
securely in place but not less than 1-1/2 inches in diameter.

C. Shop or Factory Application of Casing Liner: Comply with SMACNA’s “HVAC Duct 
Construction Standards - Metal and Flexible,” Figure 2-19, “Flexible Duct Liner Installation.”

1. Adhere a single layer of indicated thickness of casing liner with at least 90 percent 
adhesive coverage at liner contact surface area. Attaining indicated thickness with 
multiple layers of casing liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal 
noising.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of casings or cut and fit to ensure butted-edge 
overlapping.
5. Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 
fpm.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not 
exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not 
exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that 
have either channel or "Z" profiles or are integrally formed from casing wall. Fabricate 
edge facings at the following locations:

a. Fan discharges.
b. Intervals of lined casing preceding unlined duct.
c. Upstream edges of transverse joints in casings where air velocities are higher 
than 2500 fpm or where indicated.

8. Secure insulation between perforated sheet metal inner wall of same thickness as 
specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform 
distance from outer wall without compressing insulation.
SEALANT MATERIALS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
   8. Service: Indoor or outdoor.

C. Solvent-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Base: Synthetic rubber resin.
   4. Solids Content: Minimum 60 percent.
   5. Shore A Hardness: Minimum 60.
   7. Mold and mildew resistant.
   8. VOC: Maximum 395 g/L.
   9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
   10. Service: Indoor or outdoor.
   11. Substrate: Compatible with galvanized sheet steel or stainless steel.

D. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.7 PERFORMANCE REQUIREMENTS

A. Static-Pressure Classes:
   1. Upstream from Fan(s): 2-inch wg.
   2. Downstream from Fan(s): 2-inch wg 3-inch wg 4-inch wg 6-inch wg 10-inch wg

B. Acoustical Performance:
   1. NRC: 1.09 0.94 according to ASTM C 423.
   2. STC: 40 34 according to ASTM E 90.

C. Structural Performance:
   1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.
      a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft..

D. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.8 QUALITY ASSURANCE


B. Welding Qualifications: Qualify procedures and personnel according to the following:

2.9 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."
   2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
   3. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.

B. HVAC casings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 233119
AIR DUCT ACCESSORIES
SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Turning vanes.
12. Remote damper operators.
13. Duct-mounted access doors.
14. Flexible connectors.
15. Duct security bars.
16. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.
1.2 QUALITY ASSURANCE


B. Comply with AMCA 500-D testing for damper rating.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
c. Control damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

C. Source quality-control reports.

D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

E. Warranty
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Refer to respective paragraphs for approved manufacturers for each type of duct accessory product.

2.2 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and No 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Pottorff; a division of PCI Industries, Inc.
   3. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity 3000 fpm.

D. Maximum System Pressure 2-inch wg.

E. Frame: 0.063-inch thick extruded aluminum with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals Neoprene, mechanically locked.

I. Blade Axles:
   1. Material: Galvanized steel.
   2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Front of rear screens.
6. 90-degree stops.

N. Sleeve: Minimum 16-gage thickness.

2.4 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Pottorff; a division of PCI Industries, Inc.
   3. Ruskin Company.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2500 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: 0.064-inch thick, galvanized sheet steel with welded corners and mounting flange.

F. Blades:
   1. Multiple, 0.050-inch thick aluminum sheet.
   3. Action: Parallel.
   5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:
1. Material: Galvanized steel.
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Bronze.

L. Accessories:
   1. Flange on intake.
   2. Adjustment device to permit setting for varying differential static pressures

2.5 MANUAL VOLUME DAMPERS

A. Dampers to be the same as duct construction.

B. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Pottorff; a division of PCI Industries, Inc.
      b. Ruskin Company.
   2. Standard leakage rating, with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Hat-shaped, galvanized steel channels, 0.064-inch minimum thickness.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Provide single blade dampers up to 6 inch width and opposed multiblade dampers above 6 inches in width.
c. Parallel- or opposed-blade design.
d. Stiffen damper blades for stability.
e. Galvanized steel, 0.064 inch thick (16 ga.).

7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

C. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pottorff; a division of PCI Industries, Inc.
   b. Ruskin Company.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.

7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Aluminum.

D. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pottorff, a division of PCI Industries, Inc.
   b. Ruskin Company.

2. Low-leakage rating with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

3. Suitable for horizontal or vertical applications.

4. Frames:
   a. Hat shaped.
   b. Galvanized steel channels, 0.064 inch thick.
   c. Mitered and welded corners.
   d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized, roll-formed steel, 0.064 inch thick. (16 ga.).


7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.


10. Tie Bars and Brackets: Galvanized steel.

11. Accessories:
a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ruskin Company.
   b. Trox USA Inc.

2. Low-leakage rating with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

3. Suitable for horizontal or vertical applications.

4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.


7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.


10. Tie Bars and Brackets: Aluminum.

11. Accessories:
   a. Include locking device to hold single-blade dampers in a fixed position without vibration.

F. Jackshaft:
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

G. Damper Hardware:

2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.6 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Dampers to be the same as duct construction.

D. For internally lined ductwork: Provide 2 internal saddles to protect lining.

E. Frames:
   1. Hat shaped.
   2. Galvanized-steel channels, 0.064 inch thick.
   3. Mitered and welded corners.

F. Blades:
   1. Provide airfoil blades.
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2. Multiple blade with maximum blade width of 8 inches.
3. Provide dampers with parallel blades for 2 position control and opposed blades for modulating control.
4. Parallel- and opposed-blade design.
5. Galvanized steel.
6. 0.064 inch thick.

G. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F.

H. Bearings:
   1. Molded synthetic.
   2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

2.7 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity. NYC projects only

D. Dampers shall contain a NYC MEA# and be approved for use in NYC.

E. Fire Rating: 1-1/2 and 3 hours.
F. Frame: Curtain type with blades outside airstream (“Type B”); fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

G. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

H. Mounting Orientation: Vertical or horizontal as indicated.

I. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

J. Horizontal Dampers: Include blade lock and stainless-steel closure spring.


L. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F and 212 deg F rated.

M. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

N. Provide fire dampers as noted on the plans and in ducts and openings in the following:
   a. Shafts.
   b. Floors.
   c. Fire walls.
   d. Fire-resistance partitions.
   e. Fire rated ceilings.
   f. Exit corridor walls.

O. Provide access door in duct adjacent to each fire damper.
2.8 CEILING DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ruskin Company.
   2. Pottorff; a division of PCI Industries, Inc.

B. General Requirements:
   1. Labeled according to UL 555C by an NRTL.
   2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.


F. Fire Rating: 2 and 3 hours.

2.9 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ruskin Company.
   2. Pottorff; a division of PCI Industries, Inc.

B. General Requirements: Label according to UL 555S by an NRTL.
   NYC projects only

   C. Dampers shall contain a NYC MEA# and be approved for use in NYC.

   D. Frame: Multiple blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
E. Blades: Airfoil type Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.

I. Provide motor mount bracket strengthener for dampers over 10" in height.

J. Provide a 10 gauge welded vertical stiffener at each corner to prevent damper misalignment.

K. Damper Motors: Modulating or two-position action.

L. Actuators mounted out of the air stream,

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches, remote-mounted.

O. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

P. Provide access door in duct adjacent to each combination fire / smoke damper.

2.10 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc., model FSD-151, FSD-341, 1-1/2 or 3 hours rated as applicable
   2. Ruskin Company, model FSD-60, 1-1/2 or 3 hour rated as applicable

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Dampers shall contain a NYC MEA# and be approved for use in NYC.

D. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

E. Fire Rating: 1-1/2 and 3 hours.

F. Frame: multiblade type fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.


H. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
I. Blades: 14 gauge galvanized airfoil shaped double skin, single piece construction, maximum 6 inches wide.

J. Leakage: Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

M. Provide motor mount bracket strengthener for dampers over 10" in height.

N. Provide a 10 gauge welded vertical stiffener at each corner to prevent damper misalignment.

O. Master control panel for use in dynamic smoke-management systems.

P. Damper Motors: Modulating or two-position action.

Q. Actuators mounted out of the air stream.

R. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Electrical Connection: 115 V, single phase, 60 Hz.

S. Accessories:

1. Auxiliary switches for position indication. Multiple damper sections that are part of the same damper can be wired in series as one large damper indicator.
2. Test and reset switches, remote mounted.

T. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

U. Provide combination fire / smoke dampers as noted on the plans and in ducts and openings in the following:
   a. Shafts.
   b. Floors.
   c. Fire walls.
   d. Fire-resistance partitions.
   e. Fire rated ceilings.
   f. Exit corridor walls.

V. Provide access door in duct adjacent to each combination fire / smoke damper.

2.11 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.

B. Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA’s “HVAC Duct Construction Standards - Metal and Flexible”; “Vanes and Vane Runners,” and “Vane Support in Elbows.”

D. Vane Construction: Double wall.

E. The maximum unsupported vane length shall not exceed 48 inches.

F. Single vane and short radius vanes are not acceptable.

2.12 REMOTE DAMPER OPERATORS

A. of the following:

1. Pottorff; a division of PCI Industries, Inc.
2. Ventfabrics, Inc.
3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 2 inches deep.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.13 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Greenheck Fan Corporation.

1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.

2.14 DUCT ACCESS PANEL ASSEMBLIES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Ductmate Industries, Inc.
   2. Flame Gard, Inc.
   3. 3M.
B. Labeled according to UL 1978 by an NRTL.
C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.15 FLEXIBLE CONNECTORS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. Ventfabrics, Inc.
B. Materials: Flame-retardant or noncombustible fabrics.
C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

   1. Minimum Weight: 26 oz./sq. yd.
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

   1. Minimum Weight: 16 oz./sq. yd.
   2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

   1. Minimum Weight: 14 oz./sq. yd.
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.16 DUCT SECURITY BARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carnes.
2. KEES, Inc.
3. Lloyd Industries, Inc.
4. Metal Form Manufacturing, Inc.
5. Price Industries.

B. Description: Field- or factory-fabricated and field-installed duct security bars.

C. Configuration:

1. Frame: 10 gage by 2 inches.
2. Sleeve: 3/16-inch, continuously welded steel frames with 1-by-1-by-3/16-inch angle frame factory welded to 1 end. To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
3. Horizontal Bars: 1/2 inch 2 by 1/4 inch .
5. Bar Spacing: 6 inches.
6. Mounting: Bolted or welded with masonry anchors.

2.17 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.18 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300
AXIAL HVAC FANS
SECTION 233413 - AXIAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Tubeaxial fans.
2. Vaneaxial fans.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
   1. Test and rate all fans in accordance with the standards of AMCA. All fans shall bear the AMCA rating and seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Project Altitude: Base fan performance ratings on actual Project site elevations above sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
1. Certified fan performance curves with system operating conditions indicated.

2. Submit the family of rpm curves indicating operating point relative to fan class.

3. Drive construction and rating.

4. Catalog cuts and dimension drawings.

5. Submit all selected sheave (fan and motor) calculations.

6. Correction chart for fans equipped with variable inlet vanes indicating performance at various percentage of opening.

7. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.

8. Certified fan sound-power ratings.

9. Motor ratings and electrical characteristics, plus motor and electrical accessories.

10. Material thickness and finishes, including color charts.

11. Dampers, including housings, linkages, and operators.

12. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For axial fans to include in emergency, operation, and maintenance manuals.

E. Warranty
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Aerovent; a Twin City Fan Company.
   2. Greenheck.
   3. Hartzell Fan, Inc.
   4. Howden Fan Co.
   5. Loren Cook Company.
   6. New York Blower Company

2.2 GENERAL

A. Make appropriate allowances for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.

B. Fans shall be non-overloading and operate stably without surging at design conditions.

C. Fan characteristic curves provided by manufacturer must be such that the fan operating point:
   1. Is to the right of peak efficiency.
   2. Is on the steep part of the fan curve such that an increase in static pressure over the specified duty results in not more than the same percent decrease in volume (CFM) and does not affect the stability of fan operation.
   3. Is no greater than 60 to 70 percent of the peak static pressure.
   4. Has the ability to provide an allowable increase in fan speed of 15 percent above the design point without surging or increasing the class of fan.

D. Provide non-overloading design, except as noted with minimum capacities as noted and with certified ratings by AMCA. Where variable inlet vanes are used, complete assembly shall be factory installed by the fan manufacturer. The fan horsepower performance characteristics shall be within 5 percent of published catalog rating data of the standard fan without the variable inlet vanes, where no data is available for the fan with inlet vanes. Inlet vanes shall
be capable of reducing flow to 20 percent of design cfm at 1-1/2 inch w.g. static pressure and maintain stable performance. Inlet vanes and all operating linkages shall be provided and assembled by fan manufacturer prior to shipment to job site.

E. Wheel shall be factory balanced statically and dynamically. Brake horsepower ratings shall be 5 percent maximum above those noted and published for a minimum of two (2) years.

F. Motor pulley shall be variable pitch diameter, for fans up to 25 hp and 1000 rpm, except fans with variable inlet vanes and VFD’s use fixed pitch, and fixed pitch diameter, over 25 hp or 1000 rpm. Supply and install one fixed pitch pulley change, as required, per fan to balance systems. Companion sheaves shall maintain belts parallel. Belt guards shall be in compliance with OSHA regulations and with tachometer opening for fan speed measurements. Manufacturer shall provide replacement fixed pitched sheaves where needed to balance system.

G. Provide removable flanged screens at inlets or outlets where no connecting ductwork is indicated, including inlets to fans in field erected casings.

H. Bearings shall be ball, roller or taper. Provide pressure type lubricating fittings with pressure relief fittings extended to accessible locations, lubricating fittings shall be similar to Alemite. Pressure relief fittings shall be similar to Keystone. For fans 27 inch and larger, provide housings horizontally split, roller bearings.

I. Provide spark resistant construction fans in accordance with AMCA Standards Type A, B or C. Type A: All where noted, parts in contact with air shall be non-ferrous. Type B shall be non-ferrous fan wheel and shaft rings. Type C shall be with non-ferrous inlet cone and rubbing plate. Motor shall be explosion proof, Class I, Group D, Division 2. Belt drive shall be non-sparking.

J. Split construction: Provide split construction for fans too large for available doorways or passageways. Split in half along center of shaft with angles, etc., to allow removal of section without disturbing inlet and discharge connection; arranged for bolting. Provide bolts with lockwashers and nuts. Construction shall be inspected by manufacturer after field assembly and certified that they have been properly assembled and ready for proper operation.

K. The drive end of the fan shaft shall be countersunk for tachometer readings.
2.3 TUBEAXIAL FANS

A. Description: Fan wheel and housing, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.
   1. Fabrication Class: AMCA 99, Class I, II and III.

B. Housings: Steel with flanged inlet and outlet connections.

C. Wheel Assemblies: Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

D. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.5.
   2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   4. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
   5. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
   7. Shaft Bearings: Radial, self-aligning ball or roller bearings.
      a. Ball-Bearing Rating Life: ABMA 9, L10 of 120,000 hours.
      b. Roller-Bearing Rating Life: ABMA 11, L10 of 120,000 hours.
      c. Extend lubrication lines to outside of casing and terminate with grease fittings.

E. Accessories:
   1. Companion Flanges: Rolled flanges of same material as housing.
   2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
   3. Propeller Access Section Door: Short duct section bolted to fan inlet and outlet allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
   4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
   5. Mounting Clips: Horizontal ceiling clips welded to fan housing, of same material as housing.
   6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
9. Backdraft Dampers: Butterfly style, for bolting to the discharge of fan or outlet cone, of same material as housing.
10. Shaft Seal: Elastomeric seal and Teflon wear plate, suitable for up to 300 deg F.
11. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
12. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation of same material as housing.
13. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
15. Outlet Cones: Round-to-round transition of same material as housing.
16. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

F. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Enclosure Type: Totally-enclosed, fan-cooled
   2. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

G. Factory Finishes:
   1. Sheet Metal Parts: Prime coat before final assembly.
   2. Exterior Surfaces: Baked-enamel finish coat after assembly.
   3. Coatings Epoxy for contaminated exhaust application.
      a. Apply to finished housings.
      b. Apply to fan wheels.

H. Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
d. 4th Octave: <Insert dB.>
e. 5th Octave: <Insert dB.>
f. 6th Octave: <Insert dB.>
g. 7th Octave: <Insert dB.>
h. 8th Octave: <Insert dB.>

I. Sound Power: <Insert sones>

2.4 VANEAXIAL FANS

A. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.
   1. Fabrication Class: AMCA 99, Class I, II, and III.
   2. Variable-Pitch Fans: Internally mounted pneumatic or electric actuator, externally mounted positive positioner, and mechanical-blade-pitch indicator.

B. Housings: Steel.
   1. Inlet and Outlet Connections: Flanges.
   2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.

C. Wheel Assemblies: Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced.

D. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.15.
   2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   4. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
   5. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
   7. Shaft Bearings: Radial, self-aligning ball or roller bearings.
      a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
c. Extend lubrication lines to outside of casing and terminate with grease fittings.

e. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan inlet and outlet allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swing-out Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: Horizontal ceiling clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
9. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section of same material as housing.
10. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
11. Flow Measurement Port: Pressure measurement taps installed in the inlet of fan to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
12. Shaft Seal: Elastomeric seal and Teflon wear plate, suitable for up to 300 deg
13. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
14. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation of same material as housing.
15. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
16. Inlet Cones: Round-to-round transition of same material as housing.
17. Outlet Cones: Round-to-round transition of same material as housing.
18. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

F. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled
2. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

G. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: Epoxy for contaminated exhaust application.

   a. Apply to finished housings.
   b. Apply to fan wheels.

H. Sound Power:

   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

I. Sound Power: <Insert sones>
2.5 MIXED-FLOW FANS

A. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt drive, and accessories.
   1. Fabrication Class: AMCA 99, Class I II and III.

B. Housings: Steel.
   1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
   2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
   3. Mixed-Flow Outlet Connection: One flanged discharge(s) perpendicular to fan inlet.

C. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

D. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.5.
   2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
      a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
      b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
      c. Extend lubrication lines to outside of casing and terminate with grease fittings.

E. Accessories:
   1. Mounting Clips: Horizontal ceiling clips welded to fan housing, of same material as housing.
   2. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
   3. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section of same material as housing.
4. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
5. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
6. Inlet Cones: Round-to-round transition of same material as housing.
7. Outlet Cones: Round-to-round transition of same material as housing.
8. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

F. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled
2. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

G. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: Epoxy for contaminated exhaust application.
   a. Apply to finished housings.
   b. Apply to fan wheels.

H. Sound Power:

a. 1st Octave: <Insert dB.>
b. 2nd Octave: <Insert dB.>
c. 3rd Octave: <Insert dB.>
d. 4th Octave: <Insert dB.>
e. 5th Octave: <Insert dB.>
f. 6th Octave: <Insert dB.>
g. 7th Octave: <Insert dB.>
h. 8th Octave: <Insert dB.>

I. Sound Power: <Insert sones.>
2.6 SOURCE QUALITY CONTROL


2.7 FAN PERFORMANCE RATINGS: ESTABLISH FLOW RATE, PRESSURE, POWER, AIR DENSITY, SPEED OF ROTATION, AND EFFICIENCY BY FACTORY TESTS AND RATINGS ACCORDING TO AMCA 210, “LABORATORY METHODS OF TESTING FANS FOR RATING.”

2.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Balance all fan wheels and all other moving components statically and dynamically. Where a coating is specified and it affects the balance of the fan wheel, perform the balancing after the coating has been applied.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Refer to Division 23 Section “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing procedures.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. For units with variable frequency drives lock out critical frequencies before initial start.
13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
14. Replace fan and motor pulleys as required to achieve design airflow.
15. Shut unit down and reconnect automatic temperature-control operators.
16. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 233413
CENTRIFUGAL HVAC FANS
SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.
3. Forward-curved centrifugal fans.
4. Plenum fans.
5. Plug fans.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
1. Test and rate all fans in accordance with the standards of AMCA. All fans shall bear the AMCA rating and seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Submit the family of rpm curves indicating operating point relative to fan class.
3. Drive construction and rating.
4. Catalog cuts and dimension drawings.
5. Submit all selected sheave (fan and motor) calculations.

6. Correction chart for fans equipped with variable inlet vanes indicating performance at various percentage of opening.

7. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.

8. Certified fan sound-power ratings.
9. Motor ratings and electrical characteristics, plus motor and electrical accessories.
10. Material thickness and finishes, including color charts.
11. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Factory/Field quality-control test reports.

D. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

E. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Aerovent; a Twin City Fan Company.
2. Greenheck.
3. Howden Fan Co.
4. Loren Cook Company.
5. New York Blower Company

2.2 GENERAL

A. Make appropriate allowances for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.

B. Fans shall be non-overloading and operate stably without surging at design conditions.

C. Fan characteristic curves provided by manufacturer must be such that that the fan operating point:
   1. Is to the right of peak efficiency.
   2. Is on the steep part of the fan curve such that an increase in static pressure over the specified duty results in not more than the same percent decrease in volume (CFM) and does not affect the stability of fan operation.
   3. Is no greater than 60 to 70 percent of the peak static pressure.
   4. Has the ability to provide an allowable increase in fan speed of 15 percent above the design point without surging or increasing the class of fan.

D. Provide non-overloading design, except as noted with minimum capacities as noted and with certified ratings by AMCA. Where variable inlet vanes are used, complete assembly shall be factory installed by the fan manufacturer. The fan horsepower performance characteristics shall be within 5 percent of published catalog rating data of the standard fan without the variable inlet vanes, where no data is available for the fan with inlet vanes. Inlet vanes shall be capable of reducing flow to 20 percent of design cfm at 1-1/2 inch w.g. static pressure and maintain stable performance. Inlet vanes and all operating linkages shall be provided and assembled by fan manufacturer prior to shipment to job site.

E. Wheel shall be factory balanced statically and dynamically. Brake horsepower ratings shall be 5 percent maximum above those noted and published for a minimum of two (2) years.
F. Motor pulley shall be variable pitch diameter, for fans up to 25 hp and 1000 rpm, except fans with variable inlet vanes and VFD’s use fixed pitch, and fixed pitch diameter, over 25 hp or 1000 rpm. Supply and install one fixed pitch pulley change, as required, per fan to balance systems. Companion sheaves shall maintain belts parallel. Belt guards shall be in compliance with OSHA regulations and with tachometer opening for fan speed measurements. Manufacturer shall provide replacement fixed pitched sheaves where needed to balance system.

G. Provide removable flanged screens at inlets or outlets where no connecting ductwork is indicated, including inlets to fans in field erected casings.

H. Bearings shall be ball, roller or taper. Provide pressure type lubricating fittings with pressure relief fittings extended to accessible locations. Lubricating fittings shall be similar to Alemite. Pressure relief fittings shall be similar to Keystone. For fans 27 inch and larger, provide housings horizontally split, roller bearings.

I. Provide spark resistant construction fans in accordance with AMCA Standards Type A, B or C. Type A: All where noted, parts in contact with air shall be non-ferrous. Type B shall be non-ferrous fan wheel and shaft rings. Type C shall be with non-ferrous inlet cone and rubbing plate. Motor shall be explosion proof, Class I, Group D, Division 2. Belt drive shall be non-sparking.

J. Split construction: Provide split construction for fans too large for available doorways or passageways. Split in half along center of shaft with angles, etc., to allow removal of section without disturbing inlet and discharge connection; arranged for bolting. Provide bolts with lock washers and nuts. Construction shall be inspected by manufacturer after field assembly and certified that they have been properly assembled and ready for proper operation.

K. The drive end of the fan shaft shall be countersunk for tachometer readings.

2.3 AIRFOIL CENTRIFUGAL FANS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

   a. Fabrication Class: AMCA 99, Class I II and III.
b. The fan shall be of welded construction utilizing corrosion resistant fasteners. The scroll wrapper and scroll side panels shall be minimum 12 gauge steel (minimum 8 gauge steel for Class III).

B. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
   1. The entire fan housing shall have continuously welded seams for leak proof operation and shall have a minimum 1-1/2 inch outlet discharge flange. A performance cutoff shall be furnished to prevent the recirculation of air in the fan housing. Bearing support shall be minimum 1/4 inch steel. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.
   2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   3. Horizontally split, bolted-flange housing.
   4. Spun inlet cone with flange.
   5. Outlet flange.

C. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy back plate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and back plate; and cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws and special coating.

D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.
F. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.15.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
4. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
6. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
7. Inlet Screens: Grid screen of same material as housing.
8. Kitchen exhaust fans are to be arrangement #10, UL762 rated, provide grease drain, grease collector, high temperature resistant paint.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.

2.4 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

B. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontally split, bolted-flange housing.
3. Spun inlet cone with flange.
4. Outlet flange.

C. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and back plate; cast-iron or cast-steel hub riveted to back plate and fastened to shaft with set screws.

D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

F. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.15.
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
   4. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:
   1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
   2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
   3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
   4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   5. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
   6. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
7. **Inlet Screens:** Grid screen of same material as housing.
8. **Shaft Cooler:** Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
9. **Spark-Resistant Construction:** AMCA 99.
10. **Shaft Seals:** Airtight seals installed around shaft on drive side of single-width fans.
11. **Weather Cover:** Enameled-steel sheet with ventilation slots, bolted to housing.
12. **Kitchen exhaust fans** are to be arrangement #10, UL762 rated, provide grease drain, grease collector, high temperature resistant paint.

I. **Motors:** Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. **Enclosure Type:** Totally enclosed, fan cooled.

### 2.5 FORWARD-CURVED CENTRIFUGAL FANS

A. **Description:** Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

B. **Housings:** Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
   1. **Panel Bracing:** Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2. **Horizontally split, bolted-flange housing.**
   3. **Spun inlet cone with flange.**
   4. **Outlet flange.**

C. **Forward-Curved Wheels:** Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

D. **Shafts:** Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

F. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.15.
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
   4. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:
   1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
   2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
   3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
   4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.

6. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.

7. Inlet Screens: Grid screen of same material as housing.

8. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.


10. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.


12. Kitchen exhaust fans are to be arrangement #10, UL762 rated, provide grease drain, grease collector, high temperature resistant paint

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   1. Enclosure Type: Totally enclosed, fan cooled.

2.6 PLENUM FANS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

B. Airfoil Wheels: Single-width-single-inlet construction with smooth curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws and special coating.

C. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

   1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

   2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

Use for greater than 1500 RPM

E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.15.
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
   4. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

G. Accessories:
   1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

H. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Enclosure Type: Totally enclosed, fan cooled.
2.7 PLUG FANS

A. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

B. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws and special coating.

C. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.15.
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
4. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.


G. Accessories:

1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

H. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.

2.8 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.9 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Balance all fan wheels and all other moving components statically and dynamically. Where a coating is specified and it affects the balance of the fan wheel, perform the balancing after the coating has been applied.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. For units with variable frequency drives lock out critical frequencies before initial start.
13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
14. Replace fan and motor pulleys as required to achieve design airflow.
15. Shut unit down and reconnect automatic temperature-control operators.
16. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
HVAC POWER VENTILATORS
SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Utility set fans.
   2. Centrifugal roof ventilators.
   3. Axial roof ventilators.
   4. Upblast propeller roof exhaust fans.
   5. Centrifugal wall ventilators.
   6. Ceiling-mounting ventilators.
   7. In-line centrifugal fans.
   8. Propeller fans.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
   1. Test and rate all fans in accordance with the standards of AMCA. All fans shall bear the AMCA rating and seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
1. Certified fan performance curves with system operating conditions indicated.

2. Submit the family of rpm curves indicating operating point relative to fan class.

3. Drive construction and rating.

4. Catalog cuts and dimension drawings.

5. Submit all selected sheave (fan and motor) calculations.

6. Correction chart for fans equipped with variable inlet vanes indicating performance at various percentage of opening.

7. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.

8. Certified fan sound-power ratings.

9. Motor ratings and electrical characteristics, plus motor and electrical accessories.

10. Material thickness and finishes, including color charts.

11. Dampers, including housings, linkages, and operators.

12. Roof curbs.

13. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

E. Warranty
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Aerovent; a Twin City Fan Company.
   2. Greenheck.
   3. Howden Fan Co.
   4. Loren Cook Company.

2.2 GENERAL

A. Make appropriate allowances for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.

B. Fans shall be non-overloading and operate stably without surging at design conditions.

C. Fan characteristic curves provided by manufacturer must be such that the fan operating point:
   1. Is to the right of peak efficiency.
   2. Is on the steep part of the fan curve such that an increase in static pressure over the specified duty results in not more than the same percent decrease in volume (CFM) and does not affect the stability of fan operation.
   3. Is no greater than 60 to 70 percent of the peak static pressure.
   4. Has the ability to provide an allowable increase in fan speed of 15 percent above the design point without surging or increasing the class of fan.

D. Provide non-overloading design, except as noted with minimum capacities as noted and with certified ratings by AMCA. Where variable inlet vanes are used, complete assembly shall be factory installed by the fan manufacturer. The fan horsepower performance characteristics shall be within 5 percent of published catalog rating data of the standard fan without the variable inlet vanes, where no data is available for the fan with inlet vanes. Inlet vanes shall be capable of reducing flow to 20 percent of design cfm at 1-1/2 inch w.g. static pressure.
and maintain stable performance. Inlet vanes and all operating linkages shall be provided and assembled by fan manufacturer prior to shipment to job site.

E. Wheel shall be factory balanced statically and dynamically. Brake horsepower ratings shall be 5 percent maximum above those noted and published for a minimum of two (2) years.

F. Motor pulley shall be variable pitch diameter, for fans up to 25 hp and 1000 rpm, except fans with variable inlet vanes and VFD’s use fixed pitch, and fixed pitch diameter, over 25 hp or 1000 rpm. Supply and install one fixed pitch pulley change, as required, per fan to balance systems. Companion sheaves shall maintain belts parallel. Belt guards shall be in compliance with OSHA regulations and with tachometer opening for fan speed measurements. Manufacturer shall provide replacement fixed pitched sheaves where needed to balance system.

G. Provide removable flanged screens at inlets or outlets where no connecting ductwork is indicated, including inlets to fans in field erected casings.

H. Bearings shall be ball, roller or taper. Provide pressure type lubricating fittings with pressure relief fittings extended to accessible locations. Lubricating fittings shall be similar to Alemite. Pressure relief fittings shall be similar to Keystone. For fans 27 inch and larger, provide housings horizontally split, roller bearings.

I. Provide spark resistant construction fans in accordance with AMCA Standards Type A, B or C. Type A: All where noted, parts in contact with air shall be non-ferrous. Type B shall be non-ferrous fan wheel and shaft rings. Type C shall be with non-ferrous inlet cone and rubbing plate. Motor shall be explosion proof, Class I, Group D, Division 2. Belt drive shall be non-sparking.

J. Split construction: Provide split construction for fans too large for available doorways or passageways. Split in half along center of shaft with angles, etc., to allow removal of section without disturbing inlet and discharge connection; arranged for bolting. Provide bolts with lock washers and nuts. Construction shall be inspected by manufacturer after field assembly and certified that they have been properly assembled and ready for proper operation.

K. The drive end of the fan shaft shall be countersunk for tachometer readings.

L. For all fans located outdoors, except roof ventilators exposed to the weather, provide custom fitted weather guards completely enclosing the fan motor, drive and bearings. Provide
weatherproof louvers in the enclosure to permit circulation of air but to exclude rain and snow. Arrange one side of the enclosure to be completely removable for access to motors, drives, bearings and other equipment located within requiring maintenance. Construct the enclosure of 16 gauge aluminum, braced with aluminum angles. Paint the fan exterior with two coats of weatherproof aluminum paint.

2.3 UTILITY SET FANS

A. Description: Direct or Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
   a. Fabrication Class: AMCA 99, Class I II and III.
   b. The fan shall be of welded construction utilizing corrosion resistant fasteners. The scroll wrapper and scroll side panels shall be minimum 12 gauge steel (minimum 8 gauge steel for Class III).
   c. Provide arrangement one (1) for SWSI or arrangement three (3) for DWDI fans, except as noted.

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
   1. The entire fan housing shall have continuously welded seams for leak proof operation and shall have a minimum 1-1/2 inch outlet discharge flange. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. Bearing support shall be minimum 1/4 inch steel. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

2. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
   1. Blade Materials: Steel
   2. Blade Type: Backward inclined
   3. Spark-Resistant Construction: AMCA 99, Type B or C.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
E. Shaft Bearings: Pre-lubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, 150 of 200,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.15.
2. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.

G. Accessories:
1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit. Provide NEMA 3R enclosure on all units mounted outside of fan enclosure.
2. Inlet and Outlet: Flanged.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
5. Access Door: Gasketed door in scroll with latch-type handles.
7. Inlet Screens: Removable wire mesh.
10. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
11. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
12. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
13. Kitchen exhaust fans are to be arrangement #10, UL762 rated, provide grease drain, grease collector, high temperature resistant paint.
H. Coatings: Epoxy for contaminated exhaust application.

2.4 CENTRIFUGAL ROOF VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.


C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.


4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.

3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

6. Kitchen exhaust fans are to be arrangement #10, UL762 rated, provide grease drain, grease collector, high temperature resistant paint.
F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

2. Overall Height: 16 inches Subparagraphs below are optional features.
3. Damper Access extension: Provide 4", 8" or 12" high aluminum with removable access panel.
4. Sound Curb: Curb with sound-absorbing insulation matrix.
5. Pitch Mounting: Manufacture curb for roof slope.
7. Burglar Bars 5/8-inch thick steel bars welded in place to form 6-inch squares.
8. Mounting Pedestal: Galvanized steel with removable access panel.

2.5 AXIAL ROOF VENTILATORS

A. Description: Direct- or belt-driven axial fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.


C. Fan Wheel: Aluminum hub and blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Accessories:
1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside outside fan housing, factory wired through an internal aluminum conduit.

2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

5. Kitchen exhaust fans are to be UL762 rated, provide grease drain, grease collector, high temperature resistant paint.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.


2. Overall Height 16 inches Subparagraphs below are optional features.

3. Damper Access extension: Provide 4", 8" or 12" high aluminum with removable access panel.

4. Sound Curb: Curb with sound-absorbing insulation matrix.

5. Pitch Mounting: Manufacture curb for roof slope.


7. Burglar Bars 5/8-inch thick steel bars welded in place to form 6-inch squares.

8. Mounting Pedestal: Galvanized steel with removable access panel.

2.6 UPBLAST PROPELLER ROOF EXHAUST FANS

A. Description: Direct- or belt-driven propeller fans consisting of housing, wheel, butterfly-type discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

1. Damper Rods: Steel with bronze bearings.

2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
C. Fan Wheel: Replaceable, cast extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing; weatherproof housing of same material as fan housing with the following features:
   1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   2. Overall Height 16 inches Subparagraphs below are optional features.
   3. Damper Access extension: Provide 4", 8" or 12" high aluminum with removable access panel.
   4. Sound Curb: Curb with sound-absorbing insulation matrix.
   5. Pitch Mounting: Manufacture curb for roof slope.
   8. Mounting Pedestal: Galvanized steel with removable access panel.
   9. Kitchen exhaust fans are to be arrangement #10, UL762 rated, provide grease drain, grease collector, high temperature resistant paint

2.7 CENTRIFUGAL WALL VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Wall Grille: Ring type for flush mounting.
5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
6. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

2.8 CEILING-MOUNTING VENTILATORS

A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
8. Manufacturer’s standard roof jack or wall cap, and transition fittings.

2.9 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, direct belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
   a. Fabrication Class: AMCA 99, Class I II III.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   3. Companion Flanges: For inlet and outlet duct connections.
   4. Fan Guards: 1/2 by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
2.10 PROPELLER FANS

A. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.
4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

F. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

8. Vibration Isolators:
   a. Type: Elastomeric hangers.
   b. Static Deflection: 1 inch.

9. Spark Arrestance Class: B or C.

2.11 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Totally enclosed, fan cooled.

2.12 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.13 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.

5. Adjust belt tension.

6. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.

8. Balance all fan wheels and all other moving components statically and dynamically. Where a coating is specified and it affects the balance of the fan wheel, perform the balancing after the coating has been applied.

9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

10. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.

12. For units with variable frequency drives lock out critical frequencies before initial start.

13. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

14. Replace fan and motor pulleys as required to achieve design airflow.

15. Shut unit down and reconnect automatic temperature-control operators.

16. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 233423
AIR CURTAINS
SECTION 233433 - AIR CURTAINS

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes air curtains with hot-water heat steam heat electric heat and gas-fired
      heater.

1.2 QUALITY ASSURANCE
   A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air
      curtains and are based on the specific product indicated. Refer to Division 01 Section
      "Product Requirements."

   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in
      NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and
      marked for intended use.

   C. Comply with AMCA 220, "Test Methods for Air Curtain Units," for airflow, outlet velocity,
      and power consumption.

   D. Comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for
      components, construction, and rating.

       1. Certify coils according to ARI 410.

   E. Comply with NSF 37, "Air Curtains for Entranceways in Food and Food Service
      Establishments."

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS
   A. The following are base bid manufacturers:

       1. Berner International Corp.
       2. Loren Cook Company.
3. Mars Air Products; Dynaforce Division.
4. Powered Aire

2.2 MATERIALS

A. Housing Materials: Galvanized steel with electrostatically applied epoxy enamel finish over powdered mirror.
   a. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

2. Mounting Brackets: Steel, for wall or ceiling mounting.

B. Intake Louvers: Integral part of the housing, mechanically field adjustable and capable of reducing air-outlet velocity by 60 percent with louver in totally closed position.

C. Discharge Nozzle: Integral part of the housing, containing adjustable air-directional vanes with 20-degree sweep front to back.

2.3 FANS

A. Fans: Galvanized steel, Centrifugal, forward curved, double width, double inlet; statically and dynamically balanced.

B. Fan Drives: Belt, equipped with belt guards and adjustable sheaves and pulleys for adjusting air-outlet velocity.

2.4 MOTORS

A. Motor Type: Multispeed, resiliently mounted, continuous duty, totally enclosed, air over, with integral thermal-overload protection.

B. Bearings: Permanently sealed, lifetime, pre-lubricated, ball bearings.

C. Disconnect: Internal power cord with plug and receptacle.
2.5 WATER COILS

A. Description: Continuous-circuit Self-draining Cleanable coil.
B. Piping Connections: Threaded on same end opposite ends.
C. Tubes: Copper, complying with ASTM B 75.
   1. Tube Diameter: 0.625 inch.
D. Fins: Aluminum with fin spacing 0.091 inch.
E. Fin and Tube Joint: Mechanical bond.
F. Headers: Seamless copper tube with brazed joints, prime coated.
G. Frames: Galvanized-steel channel frame 0.079 inch.
H. Ratings: According to ASHRAE 33.
   1. Working-Pressure Ratings: 200 psig, 325 deg F.
I. Source Quality Control: Test to 300 psig and to 200 psig underwater.

2.6 STEAM COILS

A. Description: Distribution header coil, with threaded steam supply and condensate connections.
   1. Connections: Same end
B. Tubes: Copper, complying with ASTM B 75.
   1. Tube Diameter: 0.625 inch.
C. Fins: Aluminum with fin spacing 0.125 inch
D. Fin and Tube Joint: Mechanical bond.
E. Headers: Cast iron with cleaning plugs, and drain and air vent tappings.
F. Frames: Galvanized-steel channel frame, 0.079 inch.
G. Ratings: According to ASHRAE 33.
   1. Working-Pressure Ratings: 100 psig, 400 deg F.

H. Source Quality Control: Test to 300 psig and to 200 psig underwater.

2.7 ELECTRIC HEATING COILS

A. Coil Assembly: Comply with UL 1995.

B. Frame: Galvanized-steel frame.

C. Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath. Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

D. Over-temperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.
   1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

E. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
   1. Magnetic contactor.
   4. Toggle switches; one per step.
   5. Step controller.
   6. Time-delay relay.
   7. Pilot lights; one per step.
   8. Airflow proving switch.

2.8 GAS-FIRED HEATERS

A. Comply with AGA Z83.8, "Gas Unit Heaters."
1. AGA Approval: Bear AGA label.
2. Type of Gas: Natural.

B. Assembly and Wiring: Heaters factory assembled, piped, wired, and tested for 120-V ac.

C. Housing: Steel, with integral draft hood and inserts for suspension-mounting rods.
   1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.

D. Heat Exchanger: Stainless steel.

E. Burners: Cast iron or aluminized steel with stainless-steel inserts.

F. Power Venter: 120-V ac, with stainless-steel shaft.

G. Automatic Gas Control: 2-stage, 24-V ac valve.

H. Ignition: Electronically controlled spark with flame sensor.

2.9 FILTERS

A. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with glass-fiber media sprayed with nonflammable adhesive in galvanized-steel frame.

B. Washable Panel Filters: Removable, stainless-steel, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch-thick, stainless-steel filter frame.

C. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.10 ACCESSORIES

A. Field-Installed Thermostat: Line voltage, factory installed and wired to the junction box on air curtain.

B. Automatic Door Switch: Plunger type installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.
C. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.

D. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.

E. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type 1 12 enclosure.

F. Mounting Brackets: Adjustable mounting brackets for drum-type roll-up doors.

2.11 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing air curtains completely, perform visual and mechanical check of individual components.
2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
3. Test gas train and verify that there are no gas leaks.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Repair or replace malfunctioning units and retest as specified above.

END OF SECTION 233433
AIR TERMINAL UNITS
SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Bypass single-duct air terminal units
   2. Dual-duct air terminal units.
   3. Fan-powered air terminal units.
   4. Shutoff single-duct air terminal units.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

D. Field quality control and test reports

E. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Titus.
   2. Anemostat; a Mestek Company.
   3. Price Industries

2.2 BYPASS SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Diverting-damper assembly inside unit casing with control components located inside a protective metal shroud.

B. Casing: 0.034-inch steel.
   1. Casing Lining: Adhesive attached, 1-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Access: Removable panels for access to diverter and other parts requiring service, adjustment, or maintenance; with airtight gasket.
C. Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings Aluminum blade, with nylon-fitted pivot points.

D. Multi-outlet Attenuator Section: With three 10-inch- diameter collars; each with locking butterfly balancing damper. For hospitals and healthcare applications supply cleanflow hospital grade sound attenuators.

E. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.

F. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:
   1. Primary and secondary overtemperature protection.
   2. Nickel chrome 80/20 heating elements.
   3. Airflow switch.
   5. Fuses (for coils more than 48 A).
   7. Pneumatic-electric switches and relays.
   8. Magnetic contactor for each step of control (for three-phase coils).

G. Electric Controls: Damper actuator and thermostat.
   1. Damper Actuator: 24 V, powered closed, powered open with microswitch to energize heating control circuit.
   2. Thermostat: Wall-mounting electric type with temperature display in Fahrenheit and Celsius, and space temperature set point.
   3. Changeover Thermostat: Duct-mounting, electric type reverses action of controls when duct temperature rises 70 deg F.

H. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat.
   1. Damper Actuator: 24 V, powered closed, powered open.
   2. Thermostat: Wall-mounting electronic type with the following features:
      a. Proportional, plus integral control of room temperature.
      b. Time-proportional reheat-coil control.
c. Temperature set-point display in Fahrenheit and Celsius.
d. Auxiliary switch shall energize heating control circuit.
e. Changeover thermistor shall reverse action.

2.3 DUAL-DUCT AIR TERMINAL UNITS

A. Manufacturers:
   1. Anemostat; a Mestek Company.
   2. Titus.
   3. Price Industries

B. Configuration: Two volume dampers inside unit casing with mixing attenuator section and control components located inside a protective metal shroud.

C. Casing: 0.034-inch steel.
   1. Casing Lining: Adhesive attached, 1-inch- thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Attenuator Section: 0.034-inch steel sheet metal.
   1. Lining: Adhesive attached, 1-inch- thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
F. Multi-outlet Attenuator Section: With four 12-inch diameter collars; each with locking butterfly balancing damper.

G. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation and Control for HVAC."

H. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

1. Damper Actuators: 24 V, powered closed, spring return open.
2. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlet and air outlet.
3. Terminal Unit Controller: Pressure independent, variable-air or constant-volume controller with electronic airflow transducers factory calibrated to minimum and maximum air volumes, and having the following features:
   a. Proportional, plus integral control of room temperature.
   b. Time-proportional reheat-coil control.
   c. Occupied and unoccupied operating mode.
   d. Remote reset of airflow or temperature set points.
   e. Adjusting and monitoring with portable terminal.
   f. Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

4. Room Sensor: Wall mounting, with temperature set-point adjustment and access for connection of portable operator terminal.

I. Control Sequence:

1. Modulate cold-air and hot air dampers to maintain room temperature.

2.4 FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers:

1. Anemostat; a Mestek Company.
3. Titus.
4. Price Industries

B. Configuration: Volume-damper assembly and fan in series or in parallel arrangement inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch steel.
   1. Casing Lining: Adhesive attached, 1-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Fan Section: Galvanized-steel plenum, with direct-drive, forward-curved fan with air filter and backdraft damper.
   1. Lining: 1-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
   2. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add paragraphs below to suit Project.
   3. Motor: ECM Multispeed Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      a. Speed Control: Infinitely adjustable with electronic controls.
      b. Fan-Motor Assembly Isolation: Rubber isolators.

F. Attenuator Section: 0.034-inch steel sheet metal.
   1. Lining: Adhesive attached, 1-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

G. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
   OR

H. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:
   1. Primary and secondary over-temperature protection.
   2. Nickel chrome 80/20 heating elements.
   3. Fan interlock contacts.
   5. Fuses (for coils more than 48 A).
   7. Pneumatic-electric switches and relays.
   8. Magnetic contactor for each step of control (for three-phase coils).

I. Factory-Mounted and -Wired Controls: Electrical components shall be mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
   1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
   2. Wiring Terminations: Fan and controls to terminal strip, and terminal lugs shall match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
   3. Disconnect Switch: Factory-mounted, fused type.

J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
K. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:

1. Proportional, plus integral control of room temperature.
2. Time-proportional reheat-coil control.
3. Occupied and unoccupied operating mode.
4. Remote reset of airflow or temperature set points.
5. Adjusting and monitoring with portable terminal.
6. Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

L. Control Sequence:

1. With central system fan operating in occupied mode, sequence the controls as follows:
   a. When primary duct is pressurized, modulate volume damper to maintain room temperature.
   b. On reduced-cooling demand, close volume damper. At a field-adjustable point, air terminal fan is energized.
   c. As cooling demand increases, increase air terminal fan speed.
   d. If central duct system pressure varies, modulate volume damper to maintain constant primary airflow.
   e. If no cooling or heating demand, control enters field-adjustable, no-load band.
   f. On heating demand, energize heating coil.

2. With central system fan operating in unoccupied mode, sequence the controls as follows:
   a. On heating demand, energize air terminal unit fan and heating coil.
   b. Maintain field-adjustable setback temperature.
   c. Close volume damper.

3. With central system fan operating in occupied mode, sequence the controls as follows:
   a. On cooling demand, modulate volume damper to proportion airflow from central system.
b. On reduced-cooling demand, close volume damper. Pneumatic-electric or damper-position switch energizes fan.

c. Speed control adjusts air terminal fan speed to match downstream resistance.

d. On heating demand, energize heating coil.

4. With central system fan operating in unoccupied mode, sequence the controls as follows:

a. Cycle air terminal fan to maintain room temperature.

2.5 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

B. Casing: 0.034-inch steel.

1. Casing Lining: Adhesive attached, 1-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.

3. Air Outlet: S-slip and drive connections, size matching inlet size.

4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

C. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.

1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.

2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Attenuator Section: 0.034-inch steel sheet metal.
   1. Lining: Adhesive attached, 1-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

F. Multi-outlet Attenuator Section: With two three four <Insert number> 6-inch- 8-inch- 10-inch-diameter collars; each with locking butterfly balancing damper.

G. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed. OR

H. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:
   1. Primary and secondary over-temperature protection.
   2. Nickel chrome 80/20 heating elements.
   3. Airflow switch.
   5. Fuses (for coils more than 48 A).
   7. Pneumatic-electric switches and relays.
   8. Magnetic contactor for each step of control (for three-phase coils).

I. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation and Control for HVAC."

J. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:
   1. Damper Actuator: 24 V, powered closed, spring return open.
   2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
      a. Proportional, plus integral control of room temperature.
b. Time-proportional reheat-coil control.

c. Occupied and unoccupied operating mode.

d. Remote reset of airflow or temperature set points.

e. Adjusting and monitoring with portable terminal.

f. Communication with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC."

3. Room Sensor: Wall mounting, with temperature set-point adjustment and access for connection of portable operator terminal.

K. Control Sequence:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

2. Factory-mounted and -piped, 5-micron filter; velocity-resetting, adjustable, high-limit control; and amplifying relay.


2.6 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

2.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 233600
DIFFUSERS, REGISTERS, AND GRILLES
SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Round ceiling diffusers.
   2. Rectangular and square ceiling diffusers.
   3. Louver-face diffusers.
   4. Linear bar diffusers.
   5. Linear slot diffusers.
   6. Ceiling-integral continuous diffusers.
   7. Round induction diffusers.
   8. Linear floor diffuser plenums.
  10. Modular core supply grilles.
  11. Adjustable bar registers and grilles.
  13. Fixed face registers and grilles.
  14. Linear bar grilles.

B. Related Sections:
   1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 QUALITY ASSURANCE

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated, include the following:
1. **Data Sheet**: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. **Diffuser, Register, and Grille Schedule**: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. **Source quality-control reports.**

C. **Warranty**

**PART 2 - PRODUCTS**

2.1 **APPROVED MANUFACTURERS**

A. **The following are base bid manufacturers:**

1. **Titus.**
2. **Anemostat; a Mestek Company.**
3. **Price Industries**
4. **Precision Air**

2.2 **CEILING DIFFUSERS**

A. **Round Ceiling Diffuser:**

1. Devices shall be specifically designed for variable-air-volume flows.
5. Dampers Combination damper and grid.
6. Accessories:
   a. Equalizing grid.
   b. Plaster ring.
   c. Safety chain.
   d. Wire guard.
   e. Sectorizing baffles.
   f. Operating rod extension.
B. Rectangular and Square Ceiling Diffusers:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel Finish: Baked enamel, white
3. Face Size: 24 by 24 inches
5. Pattern: Fixed Two position Adjustable.
6. Dampers: Radial opposed blade Butterfly Combination damper and grid.
7. Accessories:
   a. Equalizing grid.
   b. Plaster ring.
   c. Safety chain.
   d. Wire guard.
   e. Sectorizing baffles.
   f. Operating rod extension.

C. Louver Face Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel Finish: Baked enamel, white
3. Face Size: <Insert inches>.
4. Mounting: T-bar
5. Pattern: Four-way Adjustable
6. Dampers Combination damper and grid.
7. Accessories:
   a. Square to round neck adaptor.
   b. Adjustable pattern vanes.
   c. Throw reducing vanes.
   d. Equalizing grid.
   e. Plaster ring.
   f. Safety chain.
   g. Wire guard.
   h. Sectorizing baffles.
   i. Operating rod extension.

2.3 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser:
Diffusers, Registers, and Grilles

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel
3. Finish: Baked enamel, white
5. Two-Way Deflection Vanes: Extruded construction fixed louvers with removable core.
6. Frame: 1-1/4 inches Retain first subparagraph below if mounting frame is required.
8. Mounting: Countersunk screw
10. Accessories Directional vanes

B. Linear Slot Diffuser:

1. Devices shall be specifically designed for variable-air-volume flows.
3. Finish - Face and Shell: Baked enamel, black.
4. Finish - Pattern Controller: Baked enamel, black.
5. Finish - Tees: Baked enamel, white.
6. Slot Width: 1 inch Number of Slots Two
7. Length 48 inches
8. Accessories: Plaster frame

C. Ceiling-Integral Continuous Diffuser:

1. Slot Width: 1 inch Retain first subparagraph below unless length is indicated on Drawings.
2. Section Length: 12 feet.
3. Straight and curved sections as required to accommodate layout.
4. Mitered tees and corners.
5. Pattern Controllers: 24 inches o.c.
7. Finishes:
   b. Interior: Standard black.
8. Throw: Standard
9. Mounting: Ceiling or Sidewall.
10. Plenum: Non-insulated Other Features:
   a. Painted interior.
   b. Blank-offs.

2.4 UNDERFLOOR AIR DISTRIBUTION DIFFUSERS- CONVENTIONAL SYSTEMS

A. Round Induction Diffusers:
   2. Material: Plastic, high impact, and resistant to cart and foot traffic.
   3. Color: Gray Components:
      a. Diffuser core.
      b. Flow regulator.
      c. Dirt and liquid catch pan.
      d. Spacer flange.
      e. Gasketed under-floor compression ring.

B. Linear Floor Diffuser Plenums:
   1. Material: Steel.
   4. Components:
      a. Aluminum diffuser core.
      b. Diffuser frame.
      c. Plenum, 0.034-inch steel.

2.5 HIGH-CAPACITY DIFFUSERS

A. Drum Louver:
   5. Gasket between drum and border.
8. Mounting: Surface to wall.
9. Inlet Width: 12 inches
10. Accessories:
   a. Opposed-blade steel damper.
   b. Duct-mounting collars with countersunk screw holes.

B. Modular Core Supply Grilles:

1. Throw: Extended distance for airflow rates.
5. Blades:
   a. Airfoil, individually adjustable horizontally.
   b. Double deflection.
   c. Set in modules.

2.6 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Material: Steel
2. Finish: Baked enamel, white.
8. Mounting Concealed
9. Damper Type: Adjustable opposed blade.
10. Accessories:
    a. Front blade gang operator.
    b. Filter.
B. Adjustable Bar Grille:

1. Material: Steel
2. Finish: Baked enamel, white
3. Face Blade Arrangement: Horizontal 1/2 inch apart.
4. Core Construction: Integral
5. Rear-Blade Arrangement: Vertical spaced 1/2 inch apart.
7. Mounting Frame: Filter
8. Mounting: Concealed

C. Security Register:

1. Security Level: Medium
2. Application: Ducted return Air transfer
3. Material: Steel
4. Material Thickness: 0.19 inch
5. Finish: Baked enamel, white face Arrangement:
   a. Shape: Rectangular
   b. Design: Fixed bar
   c. Frame: Yes
   d. Deflection: Zero degrees
   e. Core: None
   f. 3/16-inch thick, front lattice plate with 2-by-2-inch square holes and 1-inch frets, 0.135-inch wire mesh, and 1/4-inch thick backer plate
   g. 3/16-inch thick, perforated faceplate with 5/16-inch diameter holes spaced 7/16 inch o.c., staggered at 60 degrees
   h. 1-1/2-inch bars and mandrel tubes and rods with zero 15-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch angle border
   i. 1-3/8-inch bars and double mandrel tubes with zero 15-degree deflection in 1-3/4-inch angle border
6. Damper Operation: Face operated
7. Damper Type: Adjustable opposed blade
8. Wall Sleeve Mechanically fastened to border

D. Security Grille:

1. Security Level: Medium
2. Application: Ducted return Air transfer
3. Material: Steel
4. Material Thickness: 0.19 inch Finish:
5. Baked enamel, white Face Arrangement:
   a. Shape Rectangular
   b. Design: Fixed bar
   c. Frame: Yes
   d. Deflection: 38 degrees.
   e. Core Louvered.
   f. 3/16-inch- thick, front lattice plate with 2-by-2-inch- square holes and 1-inch frets, 0.135-inch wire mesh, and 1/4-inch- thick backer plate.
   g. 3/16-inch- thick perforated faceplate with 5/16-inch- diameter holes spaced 7/16 inch o.c., staggered at 60 degrees.
   h. 1-1/2-inch bars and mandrel tubes and rods with zero 15-degree deflection in 1-1/4-by-1-1/4-by-3/16-inch angle border.
   i. 1-3/8-inch bars and double mandrel tubes with zero 15-degree deflection in 1-3/4-inch angle border.

6. Wall Sleeve: Mechanically fastened to border.

E. Fixed Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. Titus.
   c. Price Industries

7. Mounting Concealed Damper Type: Adjustable opposed blade

F. Fixed Face Grille:
1. Material: Steel
2. Finish: Baked enamel, white

G. Linear Bar Grille:

1. Material: Steel
3. Distribution plenum.
   a. Internal insulation.
   b. Inlet damper.
6. Mounting Concealed
7. Damper Type: Adjustable opposed blade.
HVAC GRAVITY VENTILATORS
SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of roof-mounting intake and relief ventilators:

1. Louver penthouses.
2. Roof hoods.

B. Related Sections include the following:

1. Division 08 Section "Louvers and Vents" for ventilator assemblies provided as part of the general construction.
2. Division 23 Section "HVAC Power Ventilators" for roof-mounting exhaust fans.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain ventilators through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
D. Welding: Qualify procedures and personnel according to the following:

2. AWS D1.3, "Structural Welding Code-Sheet Steel."

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.

C. Samples for Verification: For each type of exposed finish required for intake and relief ventilators.

D. Welding certificates.

E. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Aerovent
   2. Greenheck.
   3. Loren Cook Company.

2.2 2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
C. **Galvanized-Steel Sheet:** ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

D. **Stainless-Steel Sheet:** ASTM A 666, Type 304, with No. 4 finish.

E. **Fasteners:** Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use hex-head or Phillips pan-head screws for exposed fasteners, unless otherwise indicated.

F. **Post-Installed Fasteners for Concrete and Masonry:** Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

G. **Bituminous Paint:** Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 **FABRICATION, GENERAL**

A. Factory or shop-fabricated intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.
2.4 LOUVER PENTHOUSES

A. Construction: All-welded assembly with 4-inch deep louvers, mitered corners, and galvanized-steel sheet roof.

B. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades.

C. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch for frames 0.064 inch for blades.

D. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.062 inch, with grain running parallel to length of blades and frame members.

1. Blade Spacing: 1.5 inches.
2. Blade Angle: 45 degrees.
3. Air Performance: Not more than 0.10-inch wg static pressure drop at 800-fpm free-area velocity.
4. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
5. Exterior Corners: Prefabricated corner units with mitered blades with concealed close-fitting splices and with fully recessed mullions at corners.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

2. Overall Height: 18 inches.

F. Bird Screening: Stainless-steel, 1/2-inch square mesh, 0.047-inch wire.

G. Insect Screening: Stainless-steel, 18-by-18 mesh, 0.009-inch wire.

H. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair.
galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer’s standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

   a. Color and Gloss: As selected by Architect from manufacturer’s full range.

2.5 ROOF HOODS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.

B. Materials: Galvanized-steel sheet, minimum 0.064-inch thick base and 0.040-inch thick hood suitably reinforced.

C. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

   2. Overall Height: 18 inches.

D. Bird Screening: Stainless-steel, 1/2-inch square mesh, 0.047-inch wire.

E. Insect Screening: Stainless-steel, 18-by-18 mesh, 0.009-inch wire.

F. Galvanized-Steel Sheet Finish:

   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer’s standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
   
   a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.6 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 5-5; with a minimum of 0.052-inch- thick, galvanized-steel sheet.

B. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

   2. Overall Height: 18 inches.

C. Bird Screening: Stainless-steel, 1/2-inch- square mesh, 0.047-inch wire.

D. Insect Screening: Stainless-steel, 18-by-18 mesh, 0.009-inch wire.

E. Galvanized-Steel Sheet Finish:

   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
   2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
   3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer’s standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

a. Color and Gloss: As selected by Architect from manufacturer's full range.
PARTICULATE AIR FILTRATION
SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ARI 850.

D. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

E. Comply with NFPA 70 for installing electrical components.

F. Comply with NFPA 90A and NFPA 90B.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

C. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

D. Warranty

E. Coordinate filter manufacturer and model numbers with facilities office.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:

1. Air Filters, Electrostatic Air Cleaners, and Filter-Holding Systems:
   a. AAF International.
   b. Airguard Industries, Inc.
   c. Barnebey & Sutcliffe Corp.
   d. Camfil Farr Co.
   e. Flanders Filters, Inc.
   f. Purafil, Inc.
   g. Bioclimatic air systems

2. Filter Gages:
   a. Airguard Industries, Inc.
   b. Dwyer Instruments, Inc.

2.2 DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with holding frames.

B. Media: Interlaced glass fibers sprayed with nonflammable adhesive and anti-microbial agent.
C.  Frame: Cardboard frame with perforated metal retainer

D.  Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.3  EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

A.  Description: Factory-fabricated, dry, extended-surface filters with holding frames.

B.  Media: Fibrous material formed into deep-V-shaped pleats with anti-microbial agent and held by self-supporting wire grid.

C.  Media and Media-Grid Frame: Fire-retardant, 1-inch particleboard with gaskets.

D.  Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

2.4  EXTENDED-SURFACE, NONSUPPORTED-MEDIA FILTERS

A.  Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames.

B.  Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and anti-microbial agent.

C.  Filter-Media Frame: Galvanized steel.

D.  Duct-Mounting Frames: Welded galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

2.5  AUTOMATIC ROLL FILTERS

A.  Description: Factory-fabricated, automatic, motor-driven, roll-type filter with holding casing.

   1.  Arrangement: Vertical.

B.  Media: Compressed and rolled, fibrous-glass material viscous-coated, and with anti-microbial agent.
C. Holding Frame: Galvanized steel with enclosed, clean media roll arranged to allow upstream replacement of filter media.

1. Auxiliary Frame: Locate on downstream side of unit with downstream side access.

D. Control and Drive: Electric, gear-reducer, motor-driven, feed-control mechanism equipped with manual media advance and run out switches for stopping media movement of filter bank and operating remote warning signal lights.

2. Automatic Control: Prewired control package to advance media when filter resistance exceeds preselected high limit after preselected operating time.

2.6 ACTIVATED-CARBON PANEL FILTERS

A. Description: Factory-fabricated unit with activated-carbon media.

B. Media: Pleated, multilayer filter with inlet layer of cotton and synthetic fibers and layer of activated-carbon granules bonded to synthetic fibers, formed into deep-V-shaped pleats and held by self-wire grid, and housed in nonflammable cardboard frame.

C. Duct-Mounting Frames: Welded galvanized steel with polyurethane gaskets and fasteners, capable of holding media and media frame in place and suitable for bolting together into built-up filter banks.

2.7 ACTIVATED-CARBON FILTERS

A. Description: Factory-fabricated unit with activated-carbon trays in deep-V arrangement with disposable panel pre-filter.


1. Activated-Carbon Capacity: 12 lb of activated carbon per 500 cfm of airflow.

C. Housing: 0.064-inch-thick, galvanized steel, for side servicing through gasketed access doors on both sides. Equip housings with metal slide channel tracks to hold activated-carbon trays.
2.8 HIGH-EFFICIENCY FILTERS

A. Description: Factory-fabricated 95 percent DOP HEPA ULPA filters with holding casing.

B. Media: UL 586, fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators vinyl-coated aluminum separators separators of ribbons of filter media.

C. Frame Material: 3/4-inch- thick, fire-retardant plywood 3/4-inch- thick, fire-retardant particleboard Galvanized steel.

D. Media to Frame Side Bond: Polyurethane foam Silicone Neoprene adhesive Fiberglass-mat packing Thermo-setting sealant Knife-edge in fluid-filled channel.

E. Face Gasket: Neoprene expanded rubber Ceramic fiber Silicone.

F. Duct-Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

2.9 ELECTRONIC AIR CLEANERS

A. Description: Galvanized-steel assembly containing electronic agglomerator and pre-filters.

B. Media: Independently supported and nested aluminum collection cells.

1. Ionizing Section: Alternately spaced grounded struts and charged ionizing wires.
2. Collecting Section: Alternately grounded and charged plates, with insulators located out of airstream.

C. Power Pack: Self-contained, prewired rectifying unit to convert 120-V, single-phase, 60Hz ac power to approximately 12,000-V dc for ionizer and 6000-V dc for collector; include overload protection, on-off switch, and pilot light showing operating status.

D. Safety Accessories: Manual-reset safety switches and warning lights for filter plenum access doors, signal lights and safety switching upstream and downstream from unit within duct, and enameled high-voltage warning signs.
2.10 FRONT- AND REAR-ACCESS FILTER FRAMES

A. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters prevent deflection of horizontal members without interfering with either filter installation or operation.

B. Pre-filters: Incorporate a separate track, removable from front or back.

C. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.

2.11 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct system.

B. Pre-filters: Integral tracks to accommodate 2-inch disposable or washable filters.

C. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from either access door. Provide ribbed bagging rim behind access door and PVC bags, for bag-in, bag-out arrangement.

D. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.12 FILTER GAGES

A. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   
   1. Diameter: 2 inches.
   2. Range: 0- to 4.0-inch wg.

B. Manometer-Type Filter Gage: Molded plastic with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg, and accurate within 3 percent of full scale range.

C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

D. Provide differential pressure indication signal to BMS.
2.13 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components, filter and filter-frame installation, and electrical wiring, and to assist in field testing. Report results in writing.

B. Operate automatic roll filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating. Correct malfunctioning units, then retest to demonstrate compliance. Remove and replace units that cannot be corrected with new units and retest.

C. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg or to designed operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.

D. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg or to designed operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510 pressure-decay method.

END OF SECTION 234100
BREECHINGS, CHIMNEYS, AND STACKS
SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Listed chimney liners.
2. Listed single and double-wall vents chimneys.
3. Listed, refractory-lined breechings and stacks.
4. Field-fabricated metal breechings and chimneys.
5. Field-fabricated diesel engine exhaust
6. Listed grease and dishwasher ducts.
7. Zero clearance fire rated shaft grease ducts

B. Related Sections include the following:

1. Division 23 Section "Draft Control Devices" for induced-draft and mechanical fans and for motorized and barometric dampers.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.


C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For the following:

1. Chimney liners.
2. Type B and BW vents.
3. Type L vents.
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

4. Special gas vents.
5. Building-heating-appliance chimneys.
7. Refractory-lined metal breechings and chimneys.
8. Guy wires and connectors.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, installation instructions, sample warranty, documentation of applicable code compliance and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations. Contractor to submit stack / draft calculations based upon the proposed system shop drawings and installation for review and approval by the engineer certifying that this installation has adequate draft to support the connected equipment.

D. Welding certificates.

E. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of anchorage devices on which the certification is based and their installation requirements.

F. Warranty: Special warranty specified in this Section.
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Metal-Fab, Inc.
   2. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
   3. Firespray International (Flamebar BW11 Fire-rated Kitchen Duct)

2.1 LISTED CHIMNEY LINERS

A. Description: Straight single-wall chimney liner tested according to UL 1777 and rated for 1000 deg F continuously, or 2100 deg F for 10 minutes; with negative or positive flue pressure complying with NFPA 211.

B. Straight Liner Materials: ASTM A 666, Type 304 stainless steel.


D. Accessories:
   1. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, cleanouts, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
   2. Sealant: Manufacturer’s standard high-temperature sealant.
   3. Insulating Fill: Manufacturer’s standard high-temperature insulation fill material in annular space surrounding chimney liner including high-temperature, ceramic-fiber insulation required to seal chimney at top and bottom.

2.2 LISTED TYPE B AND BW VENTS

A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 1/4- inch airspace.
C. Inner Shell: ASTM B 209, Type 1100 aluminum ASTM B 209, Type 3003 aluminum ASTM B 209, Type 3105 aluminum ASTM A 666, Type 430 stainless steel.

D. Outer Jacket: Galvanized Aluminized steel.

E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, cleanouts, storm collars, support assemblies, thimbles, fire-stop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Exit cone with drain section incorporated into riser.

2.3 LISTED TYPE L VENTS

A. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F continuously or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 2-inch airspace filled with high-temperature, ceramic-fiber insulation.

C. Inner Shell: ASTM A 666, Type 304 stainless steel.

D. Outer Jacket Stainless steel.

E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, cleanouts, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Exit cone with drain section incorporated into riser.

2.4 LISTED SPECIAL GAS VENTS

A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

C. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

D. Outer Jacket Stainless steel.
E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, cleanouts, adjustable roof flashings, storm collars, support assemblies, thimbles, fire-stop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Exit cone with drain section incorporated into riser.

2.5 LISTED BUILDING-HEATING-APPLIANCE CHIMNEYS

A. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F continuously or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 2-inch annular space filled with high-temperature, ceramic-fiber insulation.

C. Inner Shell: ASTM A 666, Type 304 stainless steel.

D. Description: Double-wall metal vents tested according to UL 103 and UL 959 and rated for 1400 deg F continuously, or 1800 deg F for 10 minutes; with positive or negative flue pressure complying with NFPA 211.

E. Construction: Inner shell and outer jacket separated by at least a 2-inch annular space filled with high-temperature, ceramic-fiber insulation.

F. Inner Shell: ASTM A 666, Type 304 stainless steel.

G. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F continuously or 2100 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.

H. Construction: Inner shell and outer jacket separated by at least a 2-inch annular space filled with high-temperature, ceramic-fiber insulation.

I. Inner Shell: ASTM A 666, Type 304

J. Outer Jacket: Galvanized Aluminized Stainless steel.

K. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, cleanouts, adjustable roof flashings, storm collars, support assemblies, thimbles, fire-stop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
3. Termination: Exit cone with drain section incorporated into riser.

2.6 LISTED GREASE DUCTS

A. Description: Double-wall metal vents tested according to UL 1978 and rated for 500 deg F continuously or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

B. Construction: Inner shell and outer jacket separated by at least a 3-inch annular space filled with high-temperature, ceramic-fiber insulation.

C. Inner Shell: ASTM A 666, Type 304 stainless steel.

D. Outer Jacket: Stainless steel where concealed. Stainless steel where exposed.

E. Accessories: Tees, elbows, increasers, hood connectors, terminations, adjustable roof flashings, storm collars, cleanouts, support assemblies, thimbles, fire-stop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters and drain fittings.

2.7 ZERO CLEARANCE FIRE RATED SHAFT LISTED GREASE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Metal-Fab, Inc., Model 4G
   2. Firespray International Flamebar BW11/Fire-wrap (Approved in New York City)

B. The duct shall be of the double-wall, factory-built type for exhausting grease-laden air, as described in NFPA-96, from equipment which produces exhaust air at temperatures up to 500º F continuously and 2000º F intermittently. The grease duct shall be of the double-wall, factory-built type for use with Type I kitchen hoods, as described in NFPA-96, for the transportation of air and grease laden vapors from commercial cooking operations.

C. Product must have MEA #, as applicable for use in NYC. Provide MEA# for use in NYC.

D. The duct shall be evaluated by ICBO ES, BOCA ESI, SBCCI PST & ESI and UL 1978 / UL 2221 Classified for installation without a fire-rated chase when penetrations of fire-rated partitions are stopped with the Model PIC PPK Fire stop.
E. Description: Double-wall metal vents tested according to UL 1978 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

F. Construction: Inner shell and outer jacket separated by a 4-inch annular space filled with high-temperature, ceramic-fiber insulation.

G. Inner Shell: ASTM A 666, Type 304 stainless steel.

H. Outer Jacket: Stainless type 304 steel where concealed. Provide stainless steel where exposed.

I. Accessories: Tees, elbows, increasers, hood connectors, terminations, adjustable roof flashings, storm collars, cleanouts, support assemblies, thimbles, fire-stop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters and drain fittings.

J. All products furnished under the Section shall conform to the requirements of NFPA-96. Products shall be evaluated by BOCA Evaluation Services, ICBO, SBCCI PST & ESI and UL 1978 & UL 2221 Classified as a two-hour fire-rated assembly. Products will carry the appropriate UL listing mark or label. Products shall be listed to UL-1978 for grease duct ‘0’ clearance, UL Classification: Grease Duct Assembly Sub Category (HNOB) G-1, UL Fire resistance Directory Alternate to 3 hr. Shaft Enclosure .and shall carry the appropriate UL listing mark or label.

2.8 FIELD-FABRICATED METAL BREECHINGS AND CHIMNEYS

A. Fabricate freestanding chimneys according to SMACNA's "Guide for Steel Stack Design and Construction." Design for minimum <Insert feet> high and <Insert inches> in diameter.

B. Fabricate breechings and chimneys from ASTM A 1011/A 1011M hot-rolled steel with continuously welded joints, complying with NFPA 211 for minimum metal thickness.

1. Equal to or Less Than 1.069 Sq. Ft. or 14 Inches in Diameter: 0.053 inch.
2. Up to 1.396 Sq. Ft. or 16 Inches in Diameter: 0.067 inch.
3. Up to 1.764 Sq. Ft. or 18 Inches in Diameter: 0.093 inch.
4. Larger Than Above: 0.123 inch.

C. Fabricate chimneys and vent connectors from galvanized steel, complying with NFPA 211 for minimum metal thickness.
1. Equal to or Less Than 6 Inches in Diameter: 0.019 inch.
2. Up to 10 Inches in Diameter: 0.024 inch.
3. Up to 16 Inches in Diameter: 0.029 inch.
4. Larger Than Above: 0.056 inch.

D. Fabricate chimneys and vent connectors from ASTM B 209, Type 1100 or 3003, aluminum or stainless steel, complying with NFPA 211 for the following minimum metal thicknesses:
   1. Aluminum: 0.027 inch.
   2. Stainless Steel: 0.012 inch.

E. Fabricate cleanout doors from compatible material, same thickness as breeching, bolted and gasketed.

F. Fabricate engine exhaust from ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 pipe; with welded joints and carbon-steel fittings and flanges.
   1. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
   2. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, including bolts, nuts, and gaskets
   3. Wall thickness shall be:
      a. To 2 inch: Schedule 40 with socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 48 inch: 0.375 wall thickness, butt weld ends only.

G. Diesel Engine and Natural Gas Engine Crank Case Breather Vent System:
   1. Material shall be in accordance with ASTM A 53, Grade B seamless or ERW.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80 with threaded ends at connection to equipment, or Schedule 40 with socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
2.9 GUING AND BRACING MATERIALS

A. Manufacturer to provide all required supports, guy wires and bracings required for project.

B. Cable: Three galvanized, stranded wires of the following thickness:

1. Minimum Size: 1/4 inch in diameter.
2. For ID Sizes 4 to 15 Inches: 5/16 inch.
3. For ID Sizes 18 to 24 Inches: 3/8 inch.
4. For ID Sizes 27 to 30 Inches: 7/16 inch.
5. For ID Sizes 33 to 36 Inches: 1/2 inch.
6. For ID Sizes 39 to 48 Inches: 9/16 inch.
7. For ID Sizes 51 to 60 Inches: 5/8 inch.


2.10 APPLICATION

A. Listed Chimney Liners: High-efficiency boiler or furnace vents in masonry chimney, dishwasher exhaust, or Type II commercial kitchen hood.

B. Listed Type B and BW Vents: Vents for certified gas appliances.

C. Listed Type L Vent: Vents for low-heat appliances.

D. Listed Special Gas Vent: Condensing gas appliances.


F. Zero clearance fire rated Listed Grease Ducts: Type I commercial kitchen grease duct. Fire rated shaft construction.

G. Field-Fabricated Metal Breechings and Chimneys: Dual-fuel boilers, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.

END OF SECTION 235100
DRAFT CONTROL DEVICES
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Draft inducer fans.
2. Venturi-draft inducer fans.
3. Mechanical-draft vent fans.
4. Vent exhaust fans.
5. Barometric dampers.
6. Vent dampers.
7. Combustion-air fans.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for fans and dampers. Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, hangers and seismic restraints, and location and size of each field connection.


C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations. Contractor to submit stack / draft calculations based upon the proposed system shop
drawings and installation for review and approval by the engineer certifying that this installation has adequate draft to support the connected equipment.

D. Operation and Maintenance Data: For draft control devices to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. EXHAUSTO, Inc.
   2. Tjernlund Products, Inc.

2.2 DRAFT INDUCER FANS

A. Fan Construction: Galvanized-steel housing and radial-blade centrifugal fan.

B. Controls:
   1. Draft proving switch.
   2. Control kit to cycle fan with gas flow to a single burner.

2.3 MECHANICAL-DRAFT VENT FANS

A. Fan Construction: Forward curved centrifugal fan and scroll fabricated of galvanized steel; direct-drive, ball-bearing motor lubricated with synthetic oil; internal cooling fan; stainless-steel shaft; and integral pressure-sensing switch.

B. Controls:
   1. Draft proving switch.
   2. Control kit to cycle fan with gas flow to multiple burner(s).
C. Accessories:

2.4 VENT EXHAUST FANS

A. General: Centrifugal fan with variable-speed control mounted at end of vertical vent.

B. Test Standard: UL 378.

C. Fan Construction: Galvanized-steel housing Galvanized-steel vent. Cast-aluminum Stainless-steel wheel. Backward-inclined centrifugal or axial fan wheel statically and dynamically balanced. Provide access to clean the discharge area. Concentric makeup air inlet duct surrounding the vent to allow zero clearance to combustibles.

D. Motor: Fully enclosed, variable-speed duty, permanent split capacitor, out of the airstream, with prelubricated and sealed ball bearings.

E. Constant-Speed Controls: Boiler interlock relay starts fan when burner control cycles on. Pressure switch permits burner operation via interlock with boiler. Fan proving switch is adjustable between minus 0.07- and minus 0.15-inch wg.

F. Variable-Speed Controls: Boiler interlock relay starts fan when burner control cycles on. Pressure controller, control transformer, and miscellaneous controls for automatic modulation of fan speed to maintain preset negative pressure between 0- and minus 1.0-inch wg. Include controller with indicator lights, pressure differential transmitter, chimney pressure sensor probe, and fan proving switch adjustable between minus 0.07- and minus 0.15-inch wg. Include tubing.

2.5 BAROMETRIC DAMPERS


2.6 VENT DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Effikal International Inc.
2. Field Controls L.L.C.; Venting Solutions Company (The).

B. Damper Construction: Stainless-steel damper blade, shaft, and vent pipe with metal, pre-lubricated bearings.

1. Electric motor sized to power damper open and closed in approximately 15 seconds in each direction. Power is off when damper is at rest.

C. Controls:

1. Control transformer.
2. Keyed wiring harness.
3. Damper end-switch to prove damper is open.
4. Interlock with boiler to permit burner operation when damper is open.
5. Hold-open switch for troubleshooting boiler controls.

2.7 COMBUSTION-AIR FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. EXHAUSTO, Inc.
2. Tjernlund Products, Inc.

B. Fan Construction: Galvanized-steel housing; steel forward-curved fan and scroll; direct-drive, totally enclosed, fan-cooled motor with ball bearings; stainless-steel shaft; and integral pressure-sensing switch.

1. Internal bypass to temper supply-air temperature to room.

C. Controls:

1. Fan proving switch to permit burner operation when combustion-air fan is operating.
2. Multiple appliance control starts fan with operation of any one of four appliances.
3. Modulating combustion-air fan speed to control pressure differential in room with respect to outdoors.
5. Optional Controls:
2.8 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.9 CAPACITIES AND CHARACTERISTICS

A. Fan:
   1. Manufacturer: <Insert manufacturer.>
   2. Model No: <Insert number.>
   3. Rated Appliance Input: <Insert Btu/h.>
   5. Speed: <Insert value> rpm.
   7. Electrical Characteristics:
      b. Volts: 115 208 230 460 <Insert value> V.
      c. Phase: Single Three.
      d. Hertz: 60.
      e. Full-Load Amperes: <Insert value.>
      f. Minimum Circuit Ampacity: <Insert value.>
      g. Maximum Overcurrent Protection: <Insert amperage.>

B. Damper:
   1. Manufacturer: <Insert manufacturer.>
   2. Model No: <Insert number.>
   3. Rated Appliance Input: <Insert Btu/h.>
   5. Electrical Characteristics:
b. Volts: 115 <Insert value> V.
c. Phase: Single.
d. Hertz: 60.
e. Full-Load Amperes: <Insert value.>
f. Minimum Circuit Ampacity: <Insert value.>
g. Maximum Overcurrent Protection: <Insert amperage.>

END OF SECTION 235113
ELECTRIC BOILERS
SECTION 235213 - ELECTRIC BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled electric boilers, trim, and accessories for generating hot water or steam.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. NFPA Compliance: Design and fabricate boilers to comply with NFPA 70, "National Electrical Code," Article 424, Paragraphs G and H.

D. UL Compliance: Test boilers for compliance with UL 834, "Heating, Water Supply, and Power Boilers-Electric." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Boilers to contain a NYC MEA #

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

2. Startup service reports.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:

1. Bryan Steam, LLC.
2. Cleaver-Brooks; div. of Aqua-Chem, Inc.
2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested electric boilers with trim and controls necessary to generate hot water or steam.

B. Pressure Vessel: Carbon-steel pressure vessel mounted on structural-steel base.

C. Nozzles: Flanges for water inlet and steam outlet and heating element inserts; threaded connections for trim and controls.

D. Insulation: Two layers of minimum 2-inch-thick, glass-fiber insulation.

E. Jacket: Galvanized sheet metal casing with powder-coated protective finish and removable panels with snap-in or interlocking closures for access to pressure vessel.

F. Lifting Lugs: Welded to pressure vessel, extending above jacket.

G. Heating Elements: Incoloy-sheathed, replaceable electric-resistance element, rated 20 kW maximum, with maximum 50 W/sq. in. 75 W/sq. in. over heat-transfer length.

H. Mounting base to secure boiler to concrete base.

   1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

2.3 TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9, Building Services Piping."

B. Aqua-stat Controllers: Operating auto-reset high limit.

C. Safety Relief Valve: ASME rated.
D. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and temperature gage. Gages shall have operating-pressure and temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Dip-tube in water outlet.

G. Drain Valve: Minimum NPS 3/4 hose-end ball valve sized per requirements of authorities having jurisdiction.

H. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of pressure vessel and sealed with fiber gasket.
   1. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   2. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.4 TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9, " Building Services Piping."

B. Pressure Controllers: Operating auto-reset high limit.

C. Safety Relief Valve:
   1. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
   2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
      a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

D. Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

E. Water Column: Minimum 12-inch glass gage with shutoff cocks.
F. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

G. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ANSI B31.1.

H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.

I. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

J. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of pressure vessel and sealed with fiber gasket.

1. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.5 CONTROLS

A. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Step controller.
3. Recycling relay returns controller to off position after power failure.
5. Control circuit switch.
7. Supply-voltage indicator.
8. Set-Point Adjust: Set points shall be adjustable.
9. Operating Level Control: Factory wired and mounted to cycle feedwater pump(s) for makeup water control.
10. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control element sequence controller to reset supply-water temperature inversely with outside-air
temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F. At 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

11. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control element sequence controller to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.

a. Include automatic, alternating-operation sequence for multiple boilers to provide equal runtime for boilers.

B. Safety Controls: To maintain safe operating conditions, safety controls limit boiler operation.

1. High Cutoff: Automatic reset stops boiler if operating conditions rise above set point or maximum boiler design pressure.
3. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

4. Hardwired Points:
   a. Monitoring: On/off status, common trouble alarm, low water level alarm.
   b. Control: On/off operation, hot water supply temperature set-point adjustment, steam pressure adjustment.

5. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.6 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, transformers, and electrical devices necessary shall provide a single-point field power connection to boiler.

1. Field power interface shall be to circuit breaker.
2. Interlock with door to de-energize power with door open.
B. Electrical Enclosures: NEMA 250, Type 1 enclosure with hinged door and key-locking handle.

C. Install factory wiring outside of an enclosure in a metal raceway.

D. Comply with NFPA 70.

E. Connectors: Mechanical lugs bolted to copper bus bars or distribution blocks with pressure connectors.

F. Fuses: NEMA FU 1, Class J or K5; 60 A, maximum.

G. Contactors: 3-pole magnetic contactors, listed for 500,000 cycles at full load.

H. Factory-wired internal control devices and heating elements.
   1. Wiring shall be numbered and color coded to match the wiring diagram.

2.7 CAPACITIES AND CHARACTERISTICS

A. Heating Medium: Hot water or Steam.

B. Design Pressure Rating: 160 psig.

C. Safety Relief Valve Setting: <Insert psig.>

D. Entering-Water Temperature: <Insert deg F.>

E. Leaving-Water Temperature: <Insert deg F.>

F. Design Water Flow Rate: <Insert gpm.>

G. Design Pressure Drop: <Insert psig.>

H. Steam Operating Pressure: <Insert psig.>

I. Steam Flow Rate: <Insert lb/h.>

J. Output Capacity: <Insert MBh.>
K. Equivalent Direct Radiation: <Insert EDR.>

L. Tankless Water Heater:
   2. Design Pressure Drop: <Insert psig.>
   3. Entering-Water Temperature: <Insert deg F.>
   4. Leaving-Water Temperature: <Insert deg F.>

M. Electrical Characteristics:
   1. kilowatts: <Insert value.>
   2. Volts: 208 480 <Insert value> V.
   3. Phase: Three.
   4. Hertz: 50 60.
   5. Full-Load Amperes: <Insert value.>

2.8 SOURCE QUALITY CONTROL
A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatic Test: Factory test assembled boiler including hydrostatic test.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

2.9 FIELD QUALITY CONTROL
A. Perform tests and inspections and prepare test reports.
   1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer’s written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of water level and water temperature or steam pressure.
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
   3. Perform field performance tests to determine the capacity of boilers.
   4. Repeat tests until results comply with requirements indicated.
   5. Provide analysis equipment required to determine performance.
   6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

END OF SECTION 235213
CONDENSING BOILERS
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, pulse-combustion fire-tube watertube water-jacketed condensing boilers, trim, and accessories for generating hot water or steam.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."


E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. Boilers to contain a NYC MEA #.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:

1. Fulton Boiler Works, Inc.
2. Hydrotherm, Inc.; a division of Mestek, Inc.
3. AERCO International.
4. Hydrotherm, Inc.; a division of Mestek, Inc.
2.1 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, pulse-combustion condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger: Carbon-steel primary and secondary combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Exhaust De-coupler: Fiberglass composite material in a corrosion-resistant steel box.

E. Burner: Natural gas, self-aspirating and self-venting after initial start.

F. Blower: Centrifugal fan to operate only during start of each burner sequence.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosure: NEMA 250, Type 1A.
   4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
   6. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
   7. Mounting base to secure boiler to concrete base.
a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

J. Mufflers: Carbon-steel intake muffler and stainless-steel exhaust.

K. Condensate Trap: Cast-iron body with stainless-steel internal parts.

L. Characteristics and Capacities:

1. Heating Medium: Hot water or Steam.
2. Design Water Pressure Rating: 150 psig
4. Entering-Water Temperature: <Insert deg F.>
5. Leaving-Water Temperature: <Insert deg F.>
10. Steam Flow Rate: <Insert lb/h.>
13. DOE Output Capacity: <Insert MBh.>
14. Equivalent Direct Radiation: <Insert EDR.>
15. Blower:
   b. RPM: <Insert value.>

16. Electrical Characteristics:
   a. Volts: 115 208 230 460 <Insert value> V.
   b. Phase: Single Three.
   c. Hertz: 50 60.
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
   f. Maximum Overcurrent Protection: <Insert amperage.>
2.2 MANUFACTURED UNITS

A. **Description:** Factory-fabricated, assembled, and tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. **Heat Exchanger:** Nonferrous, corrosion-resistant combustion chamber.

C. **Pressure Vessel:** Carbon steel with welded heads and tube connections.

D. **Burner:** Natural gas, forced draft.

E. **Blower:** Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.

   1. **Motors:** Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

      a. **Motor Sizes:** Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. **Gas Train:** Combination gas valve with manual shutoff and pressure regulator.

G. **Ignition:** Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. **Casing:**

   1. **Jacket:** Sheet metal, with snap-in or interlocking closures.
   2. **Control Compartment Enclosures:** NEMA 250, Type 1A.
   3. **Finish:** Powder-coated protective finish.
   4. **Insulation:** Minimum 2-inch-thick, mineral-fiber polyurethane-foam insulation surrounding the heat exchanger.
   5. **Combustion-Air Connections:** Inlet and vent duct collars.
   6. **Mounting base to secure boiler.**

      a. **Seismic Fabrication Requirements:** Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

I. **Characteristics and Capacities:**
2. Design Water Pressure Rating: 160 psig
3. Safety Relief Valve Setting: <Insert psig.>
4. Entering-Water Temperature: <Insert deg F.>
5. Leaving-Water Temperature: <Insert deg F.>
11. DOE Output Capacity: <Insert MBh.>
12. Equivalent Direct Radiation: <Insert EDR.>
13. Blower:
   b. RPM: <Insert value.>

14. Electrical Characteristics:
   a. Volts: 115 208 230 460 <Insert value> V.
   b. Phase: Single Three.
   c. Hertz: 60.
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
   f. Maximum Overcurrent Protection: <Insert amperage.>

2.3 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.

C. Combustion Chamber: Stainless steel, sealed.

D. Burner: Natural gas, forced draft drawing from gas premixing valve.

E. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.

H. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.

I. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosures: NEMA 250, Type 1A.
   4. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
   6. Mounting base to secure boiler.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

J. Characteristics and Capacities:
   2. Design Water Pressure Rating: 160 psig
   3. Safety Relief Valve Setting: <Insert psig.>
   4. Entering-Water Temperature: <Insert deg F.>
   5. Leaving-Water Temperature: <Insert deg F.>
   11. DOE Output Capacity: <Insert MBh.>
12. Blower:
   b. RPM: <Insert value.>

13. Electrical Characteristics:
   a. Volts: 115 208 230 460 <Insert value> V.
   b. Phase: Single Three.
   c. Hertz: 60.
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
   f. Maximum Overcurrent Protection: <Insert amperage.>

2.4 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, water-jacketed condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Stainless-steel primary and secondary combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.

D. Burner: Natural gas, forced draft; swing-open front and burner observation port.

E. Blower: Centrifugal fan, forced draft. Include pre-purge and post-purge of the combustion chamber.

   1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.

G. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

H. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
4. Insulation: Minimum 4-inch thick, mineral-fiber insulation surrounding the heat exchanger.
6. Mounting base to secure boiler.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

I. Characteristics and Capacities:

2. Design Water Pressure Rating: 30 psig
3. Safety Relief Valve Setting: <Insert psig.>
4. Maximum Design Temperature: 210 deg F.
5. Entering-Water Temperature: <Insert deg F.>
6. Leaving-Water Temperature: <Insert deg F.>
7. Design Water Flow Rate: <Insert gpm.>
11. DOE Output Capacity: <Insert MBh.>
12. Equivalent Direct Radiation: <Insert EDR.>
13. Blower:

   b. RPM: <Insert value.>

14. Electrical Characteristics:

   a. Volts: 115 208 230 460 <Insert value> V.
   b. Phase: Single Three.
   c. Hertz: 60.
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
f. Maximum Overcurrent Protection: <Insert amperage.>

2.5 TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9, " Building Services Piping."

B. Aqua-stat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.


G. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.6 TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9, " Building Services Piping."

B. Pressure Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve:

1. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
   a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

D. Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
E. Water Column: Minimum 12-inch glass gage with shutoff cocks.

F. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

G. Blow-down Valves: Factory-installed bottom and surface, slow-acting blow-down valves same size as boiler nozzle. Blow-down valves shall be combination of slow and quick acting as required by ANSI B31.1.

H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.

I. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

2.7 CONTROLS

A. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.
6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.

   a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design pressure.
2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

C. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:
   a. Monitoring: On/off status, common trouble alarm low water level alarm.
   b. Control: On/off operation, hot water supply temperature set-point adjustment steam pressure adjustment

2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.8 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to wire lugs fused disconnect switch nonfused disconnect switch circuit breaker.
5. Provide branch power circuit to each motor and to controlscircuit breaker.
6. Provide each motor with overcurrent protection.

2.9 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.10 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

D. Boilers to contain a NYC MEA #.

2.11 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature steam pressure.
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.
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D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
   a. Test for full capacity.
   b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

END OF SECTION 235216
CAST IRON BOILERS
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged cast-iron boilers, trim, and accessories for generating [hot water] [steam] with the following configurations and burners:

1. [Factory] [Field] assembled.
2. [Atmospheric gas] [Sealed-combustion, gas] [Forced-draft, gas] [Oil] [Combination gas and oil] burner.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:

   1. Startup service reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

E. I=B=R Compliance: Boilers shall be tested and rated according to HI’s "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.

F. UL Compliance: Test boilers for compliance with [UL 726, "Oil-Fired Boiler Assemblies"] [UL 726, "Oil-Fired Boiler Assemblies," and UL 795, "Commercial-Industrial Gas Heating Equipment"] [UL 795, "Commercial-Industrial Gas Heating Equipment"]. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

G. Boilers to contain a NYC MEA #.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace controls and heat exchangers of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Controls: [Two] <Insert number> years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: [Five] [10] [20] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Burnham Hydronics.
2. Hydrotherm, Inc.; a division of Mestek, Inc.
5. Weil-McLain; a United Dominion Company.
2.2 MANUFACTURED UNITS

A. Description: Factory fabricated and [field] assembled.

1. Cast-iron sections shall be sealed pressure tight and held together with tie rods [set on an insulated steel base]; including insulated jacket and flue-gas vent connection.
2. Ship cast-iron sections disassembled with all materials and equipment, including seals, tie rods, and insulated jacket and flue-gas vent connection for field assembly.

B. Cast-Iron Section Design:

1. Configuration: [Wet [base] [back] [leg].
2. Number of Passes: [Single] [Multiple].
3. Sectional Joints: High-temperature sealant to seal flue-gas passages not in contact with heating medium, [tapered cast-iron push nipples,] [O-ring gaskets,] [fiber roping,] and held together with tie rods.
4. Drain and blowdown tappings.
5. Return injection tube to equalize water flow to all sections.
7. Built-in air separator.

C. Combustion Chamber: Equipped with [ceramic-fiber target wall] [refractory] [insulation] [and] flame observation ports, front and back.

D. Casing:

1. Jacket: [Galvanized sheet] [Sheet] metal, with snap-in or interlocking closures and [baked-enamel] [powder-coated] protective finish.
4. Access: For cleaning between cast-iron sections.
5. Draft Hood: Flue canopy and [top] [rear] flue connection shall be constructed of [aluminized] [stainless] steel containing adjustable outlet damper assembly.
6. Insulated base constructed of aluminized steel to permit boiler to be installed on combustible floor.
7. Mounting Frame: Steel rails to mount assembled boiler package on concrete base.

a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic
Controls for HVAC Piping and Equipment” when mounting base is anchored to building structure.

8. Control Cabinet: Sheet metal casing shall cover all controls, gas train, and burner.

E. Draft Diverter: [Steel assembly integral with boiler casing] [Separate galvanized-steel assembly].

2.3 BURNER

A. Burner Tubes and Orifices: [Stainless steel] [Cast iron], for [natural] [propane] gas.

B. Gas Train: Control devices and [full-modulation] [on-off] [low-high-low] control sequence shall comply with requirements in [ASME CSD-1] [FMG] [IRI] [UL].

C. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

D. Pilot: [Standing] [Intermittent-electric-spark] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

2.4 BURNER

A. Burner Tubes and Orifices: [Stainless steel] [Cast iron], for [natural] [propane] gas.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

D. Pilot: [Standing] [Intermittent-electric-spark] pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
2.5 BURNER

A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for [natural] [propane] gas.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Gas Train: Control devices and [modulating] [on-off] [low-high-low] control sequence shall comply with requirements in [ASME CSD-1] [FMG] [IRI] [UL].

D. Pilot: [Intermittent] [Interrupted]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

E. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.


2.6 BURNER

A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Oil Supply: Control devices and [modulating] [on-off] [low-high-low] control sequence shall comply with requirements in [ASME CSD-1] [FMG] [IRI] [UL].

   1. Oil Pump: Two-stage, gear-type oil pump[ integral to and directly driven by blower] shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.
   2. Oil Piping Specialties:
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b. Removable-mesh oil strainer.
c. 0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.
d. 0- to 300-psig oil-nozzle pressure gage.
e. Nozzle-line, solenoid-safety-shutoff oil valve.

D. Pilot: [Intermittent] [Interrupted]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid using [cadmium sulfide] [UV scanner] flame-safety control.

E. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.


2.7 BURNER

A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil and [natural] [propane] gas.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Oil Supply: Control devices and [modulating] [on-off] [low-high-low] control sequence shall comply with requirements in [ASME CSD-1] [FMG] [IRI] [UL].

1. Oil Pump: Two-stage, gear-type oil pump[ integral to and directly driven by blower] shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.
2. Oil Piping Specialties:

   b. Removable-mesh oil strainer.
   c. 0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.
   d. 0- to 300-psig oil-nozzle pressure gage.
   e. Nozzle-line, solenoid-safety-shutoff oil valve.

D. Gas Train: Control devices and [modulating] [on-off] [low-high-low] control sequence shall comply with requirements in [ASME CSD-1] [FMG] [IRI] [UL].
E. Gas Pilot: [Intermittent] [Interrupted]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

F. Oil Pilot: [Intermittent] [Interrupted]-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with [cadmium sulfide] [UV scanner] flame-safety control.

G. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.

2.8 TRIM

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."

B. Aquastat Controllers: Operating[, firing rate,] and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: [Automatic] [Manual].


G. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.
   1. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   2. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.9 TRIM

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."

B. Pressure Controllers: Operating[, firing rate,] and high limit.

C. Safety Relief Valve:
1. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
   a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

D. Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

E. Water Column: Minimum 12-inch glass gage with shutoff cocks.

F. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

G. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle.

H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size as or larger than nozzle. Valves larger than NPS 2 shall have rising stem.

I. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

J. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in an upper port of cast-iron sections and sealed with fiber gasket.
   1. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   2. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.10 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:
1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At [0 deg F] <Insert temperature> outside-air temperature, set supply-water temperature at [200 deg F] <Insert temperature>; at [60 deg F] <Insert temperature> outside-air temperature, set supply-water temperature at [140 deg F] <Insert temperature>.
7. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
   a. Include automatic, alternating-firing sequence for multiple boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   1. High Cutoff: [Manual] [Automatic] reset stops burner if operating conditions rise above maximum boiler design [temperature] [pressure].
   2. Low-Water Cutoff Switch: [Electronic] [Float and electronic] probe shall prevent burner operation on low water. Cutoff switch shall be [manual] [automatic]-reset type.
   4. Rollout Safety Switch: Factory mounted on boiler combustion chamber.
   5. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
   1. Hardwired Points:
      a. Monitoring: On/off status, [common trouble alarm] [low water level alarm] <Insert monitoring>.
      b. Control: On/off operation, [hot water supply temperature set-point adjustment] [steam pressure adjustment] <Insert control>.
2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.11 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a [metal] raceway.
4. Field power interface shall be to [wire lugs] [fused disconnect switch] [nonfused disconnect switch] [circuit breaker].
5. Provide branch power circuit to each motor and to controls [with disconnect switch or circuit breaker].
6. Provide each motor with overcurrent protection.

2.12 CAPACITIES AND CHARACTERISTICS

A. Heating Medium: [Hot water] [Steam].

B. Design Water Pressure Rating: [30 psig] [50 psig] [80 psig] <Insert pressure rating>.

C. Design Steam Pressure Rating: [Steam, 15 psig] <Insert pressure rating>.

D. Safety Relief Valve Setting: <Insert psig.>

Retain four paragraphs below for hot-water boilers.

E. Entering-Water Temperature: <Insert deg F.>

F. Leaving-Water Temperature: <Insert deg F.>

G. Design Water Flow Rate: <Insert gpm.>

H. Design Pressure Drop: <Insert psig.>
I. Steam Operating Pressure: <Insert psig.>

J. Steam Flow Rate: <Insert lb/h.>

K. Minimum Efficiency: <Insert AFUE.>

L. Number of Passes: [One] [Two] <Insert number>.

M. AGA Input: <Insert MBh.>

N. I=B=R Input: <Insert MBh.>

O. Gas Input: <Insert cfh.>

P. Oil Input: <Insert gph.>

Q. AGA Output Capacity: <Insert MBh.>

R. DOE Output Capacity: <Insert MBh.>

S. Net I=B=R Output Capacity: <Insert MBh.>

T. Gross I=B=R Output Capacity: <Insert MBh.>

U. Equivalent Direct Radiation: <Insert EDR.>

V. Tankless Water Heater:
   2. Design Pressure Drop: <Insert psig.>
   3. Entering-Water Temperature: <Insert deg F.>
   4. Leaving-Water Temperature: <Insert deg F.>

W. Blower:
   1. Motor Horsepower: <Insert value.>
   2. RPM: <Insert value.>

X. Electrical Characteristics:
   1. Volts: [115] [208] [230] [460] <Insert value> V.
   2. Phase: [Single] [Three].
   3. Hertz: [50] [60].
5. Minimum Circuit Ampacity: <Insert value.>

2.13 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Vibration Isolation: Elastomeric [isolator pads] [mounts] with a minimum static deflection of [0.25 inch] <Insert deflection>. Vibration isolation devices and installation requirements are specified in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment”
C. Install gas-fired boilers according to NFPA 54.

D. Install oil-fired boilers according to NFPA 31.

E. Assemble boiler sections in sequence and seal between each section.

F. Assemble and install boiler trim.

G. Install electrical devices furnished with boiler but not specified to be factory mounted.

H. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

D. Connect oil piping full size to burner inlet with shutoff valve and union.

E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

F. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

I. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

J. Connect breeching full size to boiler outlet. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks" for venting materials.

K. Install flue-gas recirculation duct from vent to burner. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks" for recirculation duct materials.
3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform installation and startup checks according to manufacturer's written instructions.
   2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
      b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and [water temperature] [steam pressure].
      c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within [12 months of date of Substantial Completion] <Insert time period>, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] <Insert number> visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.

3. Perform field performance tests to determine capacity and efficiency of boilers.
   
   a. For dual-fuel boilers, perform tests for each fuel.
   b. Test for full capacity.
   c. Test for boiler efficiency at [low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20] <Insert range> percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.

5. Provide analysis equipment required to determine performance.

6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.


3.5 DEMONSTRATION

A. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain boilers.[ Video training sessions.] Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 235223
SECTION 235233 - WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, finned water-tube boilers, trim, and accessories for generating hot water.

B. This Section includes packaged, water-tube boilers, trim, and accessories for generating hot water or steam with the following configurations, burners, and outputs:

1. Factory or Field assembled.
2. Atmospheric gas or Forced-draft gas Combination gas and oil burner.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."


E. I=B=R Compliance: Boilers shall be tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.

F. UL Compliance: Test boilers for compliance with UL 726, "Oil-Fired Boiler Assemblies" and UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

G. Boilers to have a NYC MEA #.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.
H. Other Informational Submittals:

2. Startup service reports.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Lochinvar Corporation.
   2. Patterson-Kelley.
   3. Raypak.
   4. H.B. Smith
   5. Weil-McLain

2.2 FINNED WATER-TUBE BOILERS

A. Description: Factory-fabricated, -assembled, and -tested boiler with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air intake connections, water supply and return connections, and controls.

B. Heat Exchanger:
   1. Finned copper-nickel tubing with stainless-steel baffles.
   2. Steel headers.
   3. Two-pass, vertical coil configuration.
   4. Tubes shall be sealed in header by welding

C. Combustion Chamber Internal Insulation: Interlocking panels of refractory insulation, high-temperature cements, mineral fiber, and ceramic refractory tile for service temperatures to 2000 deg F.

D. Casing:
   1. Jacket: Galvanized sheet steel, with snap-in or interlocking closures.
   2. Control Compartment Enclosure: NEMA 250, Type 1A.
3. Finish: Baked enamel over primer
4. Insulation: Minimum 2-inch thick, mineral-fiber insulation surrounding the heat exchanger.
6. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
7. Mounting base to secure boiler.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

E. Burner:


2. Vertical Burner:
   a. Ceramic to fire in a 360-degree pattern.
   b. Burner shall have a viewing port for observation of burner operation and a factory-mounted centrifugal fan to supply outside air through a replaceable 99 percent efficient (1-micrometer particles) filter to boiler burner.
   c. Fan shall be controlled to pre-purge and post-purge the combustion chamber before firing.

3. Gas Train: Control devices and full-modulation control sequence shall comply with requirements in AGA ASME CSD-1 FMG IRI UL.

4. In addition to these requirements, include shutoff cock, pressure regulator, and control valve.

5. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

6. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

7. Flue-Gas Recirculation Fans: Centrifugal fans on burner assembly to recirculate flue gas to decrease oxides of nitrogen emissions to less than 30 ppm.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
F. Trim:

1. Aqua-stat Controllers: Operating, firing rate, and high limit.
2. Safety Relief Valve: ASME rated.
3. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and temperature gage. Gages shall have operating-pressure and temperature ranges so normal operating range is about 50 percent of full range.
4. Boiler Air Vent: Automatic
6. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

G. Controls:

1. Refer to Division 23 Section "Instrumentation and Control for HVAC."
2. Boiler operating controls shall include the following devices and features:
   a. Control transformer.
   b. Set-Point Adjust: Set points shall be adjustable.
   c. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.
   d. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
3. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   a. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
   d. Rollout Safety Switch: Factory mounted on boiler combustion chamber.
   e. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
4. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
   a. Monitoring: On/off status, common trouble alarm low water level alarm.
   b. Control: On/off operation, hot water supply temperature set-point adjustment.
   c. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.3 STEEL FLEXIBLE WATER-TUBE BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bryan Steam, LLC.
2. Cleaver-Brooks; div. of Aqua-Chem, Inc.

B. Description: Factory-fabricated and field-assembled, water-tube boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls.

C. Heat-Exchanger Design: Straight steel tubes rolled into steel headers.
   1. Accessible head plates at both ends.
   2. Hand-holes or couplings in headers for water-side inspections.
   3. Accessible drain and blow-down tappings, both high and low, for surface and mud removal.
   4. Lifting lugs on top of boiler.
   5. Built-in air separator.

D. Heat-Exchanger Design: Bent steel tubes welded into steel headers with membrane water-wall design.
   1. Limit tube configurations to two.
   2. Accessible drain and blow-down tappings, both high and low, for surface and mud removal.
   3. Accessible inspection ports in drum, mud legs, and tube manifolds.
   4. Lifting lugs on top of boiler.
   5. Built-in air separator.
E. Combustion Chamber: Equipped with minimum 3-inch 2700 deg F poured refractory on floor and minimum 3-1/2-inch lap-jointed cast refractory with fiber-blanket joint seals on side walls. Combustion chamber shall have flame observation ports in front and or back.

F. Casing:

1. Insulation: Minimum 2-inch thick, lightweight refractory; 1-inch thick insulating board; galvanized-steel membrane, and 2-inch thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber.
2. Top Flue Connection: Constructed of stainless steel.
4. Mounting base to secure boiler to concrete base.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

5. Control Compartment Enclosure: NEMA 250, Type 1A.

G. Draft Diverter or Barometric Damper: Galvanized-steel assembly with flue-gas thermometer.

H. Burner:

2. Gas Train: Control devices and full-modulation control sequence shall comply with requirements in FMG.
3. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

I. Burner:

1. Burner: Welded construction with multi-vane, stainless-steel, flame-retention diffuser for natural gas. Mount burner on hinged access door to permit access to combustion chamber.
2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Gas Train: Control devices and modulating control sequence shall comply with requirements FMG

4. Pilot: Intermittent—electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

5. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.


J. Burner:

1. Burner: Welded construction with multi-vane, stainless-steel, flame-retention diffuser for fuel oil. Mount burner on hinged access door to permit access to combustion chamber.

2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Oil Supply: Control devices and modulating control sequence shall comply with requirements FMG

   a. Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.

   b. Oil Piping Specialties:

      1) Suction-line, manual, gate valve.
      2) Removable-mesh oil strainer.
      3) 0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.
      4) 0- to 300-psig oil-nozzle pressure gage.
      5) Nozzle-line, solenoid-safety-shutoff oil valve.

5. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.


K. Burner:

1. Burner: Welded construction with multi-vane, stainless-steel, flame-retention diffuser for fuel oil and natural gas. Mount burner on hinged access door to permit access to combustion chamber.

2. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

   a. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Oil Supply: Control devices and modulating control sequence shall comply with requirements FMG. Oil pump may be remotely mounted and shipped separately. Edit performance parameters in first subparagraph below to suit Project.

   a. Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.

   b. Oil Piping Specialties:

      1) Suction-line, manual, gate valve.
      2) Removable-mesh oil strainer.
      3) 0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.
      4) 0- to 300-psig oil-nozzle pressure gage.
      5) Nozzle-line, solenoid-safety-shutoff oil valve.

4. Gas Train: Control devices and modulating control sequence shall comply with requirements in ASME CSD-1 FMG IRI UL.

5. Oil Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with UV scanner flame-safety control.
6. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
   

L. Trim:

1. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9, "BuildingServices Piping."
2. Aqua-stat Controllers: Operating, firing rate, and high limit.
4. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and temperature gage. Gages shall have operating-pressure and temperature ranges so normal operating range is about 50 percent of full range.
7. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.
   
a. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
b. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

M. Trim:

1. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9, "BuildingServices Piping."
2. Pressure Controllers: Operating, firing rate, and high limit.
3. Safety Relief Valve:
   
a. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
   
   1) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

4. Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
7. Blow down Valves: Factory-installed bottom and surface, slow-acting blow down valves same size as boiler nozzle. Blow down valves shall be combination of slow and quick acting as required by ANSI B31.1.
8. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.
9. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.
10. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper manifold and sealed with fiber gasket.
   a. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
   b. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

N. Controls:

1. Refer to Division 2.3 Section "Instrumentation and Control for HVAC."
2. Boiler operating controls shall include the following devices and features:
   a. Control transformer.
   b. Set-Point Adjust: Set points shall be adjustable.
   c. Operating Pressure Control: Factory wired and mounted to cycle burner.
   d. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
   e. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature to 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F .
   f. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
   g. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
3. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   a. High Cutoff Automatic reset stops burner if operating conditions rise above maximum boiler design pressure.
   b. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
   d. Rollout Safety Switch: Factory mounted on boiler combustion chamber.
   e. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

4. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.
   a. Monitoring: On/off status, common trouble alarm low water level alarm.
   b. Control: On/off operation, hot water supply temperature set-point adjustment steam pressure adjustment.
   c. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.4 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   1. House in NEMA 250, Type 1 enclosure.
   2. Wiring shall be numbered and color-coded to match wiring diagram.
   3. Install factory wiring outside of an enclosure in a metal raceway.
   4. Field power interface shall be to circuit breaker.
   5. Provide branch power circuit to each motor and to controls circuit breaker.
   6. Provide each motor with overcurrent protection.
VENTING KITS

A. Vent Damper: Motorized, UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless-steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.

B. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, and sealant.

C. Combustion-Air Intake: Stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

CAPACITIES AND CHARACTERISTICS

A. Heating Medium: Hot water Steam.

B. Design Pressure and Temperature Rating: 160 psig, 250 deg F.

C. Design Pressure Rating: 60 psig 100 psig 140 psig 160 psig <Insert value>.

D. Design Pressure Rating: 15 psig 150 psig 250 psig <Insert value>.

E. Safety Relief Valve Setting: <Insert psig.>

F. Entering-Water Temperature: <Insert deg F.>

G. Leaving-Water Temperature: <Insert deg F.>

H. Design Water Flow Rate: <Insert gpm.>

I. Design Pressure Drop: <Insert psig.>

J. Steam Operating Pressure: <Insert psig.>

K. Steam Flow Rate: <Insert lb/h.>

L. Minimum Efficiency: <Insert AFUE.>

M. Number of Passes: One Two <Insert number>.

N. AGA Input: <Insert MBh.>

O. I=B=R Input: <Insert MBh.>
P. Gas Input: <Insert cfh.>

Q. Oil Input: <Insert gph.>

R. DOE Output Capacity: <Insert MBh.>

S. AGA Output Capacity: <Insert MBh.>

T. Net I=B=R Output Capacity: <Insert MBh.>

U. Gross I=B=R Output Capacity: <Insert MBh.>

V. Equivalent Direct Radiation: <Insert EDR.>

W. Tankless Water Heater:

2. Design Pressure Drop: <Insert psig.>
3. Entering-Water Temperature: <Insert deg F.>
4. Leaving-Water Temperature: <Insert deg F.>

X. Burner Blower:

1. Motor Horsepower: <Insert value.>
2. RPM: <Insert value.>

Y. Electrical Characteristics:

1. Volts: 115 208 230 460 <Insert value> V.
3. Hertz: 60.
5. Minimum Circuit Ampacity: <Insert value.>

2.7 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

2.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer’s written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
   b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature or steam pressure.
   c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
3. Perform field performance tests to determine the capacity and efficiency of the boilers.
a. For dual-fuel boilers, perform tests for each fuel.

b. Test for full capacity.

c. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40 and 20 percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.

5. Provide analysis equipment required to determine performance.

6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.


END OF SECTION 235233
SECTION 235233-1 - PACKAGED WATERTUBE STEAM BOILERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Vendor shall design, fabricate, assemble/disassemble, shop test, deliver and provide startup and commissioning supervision and training for two (2) Packaged Watertube, Wetback, High Pressure Steam Boiler systems, complete with all components and design features, as specified herein for installation at the New York Presbyterian Hospital 168th Street Central Boiler Plant in New York, New York. The boiler system shall be installed indoors. The boiler system materials and equipment total assembled unit and all individual components shall be standard products of the manufacturer regularly engaged in the manufacture of those products and shall be designed and constructed, in accordance with the latest applicable standards and authorities having jurisdiction. The boilers and ancillaries shall be preassembled in modules and major subassemblies to the maximum extent possible suitable for rigging, and ready for immediate site mounting on foundation attachment of connections. Pad eyes or other lifting devices shall be permanently fixed to the boiler drum, frame or other component of the boiler skid that will facilitate rigging the boiler in a vertical or horizontal position.

B. It is the intention of this specification that the Vendor shall be solely and entirely responsible for the design, procurement of materials and components, fabrication, assembly/disassembly, inspection, testing, and preparation of equipment for shipment, delivery and guarantee of the performance of the equipment, as well as the commercial liability of the entire boiler system, including subsequent startup and commissioning support, as required by the Engineer and the New York City Building Code and all authorities having jurisdiction. The individual equipment packages of the boiler system shall be integrated by the Vendor to form a completely functional system such that the Engineer need only the connection of utilities, interconnection piping, wiring and appurtenances to form a complete functional and reliable system.

C. The Vendor shall, as a minimum, furnish drawings, performance data, and descriptive information for the boiler system in detail, as specified herein.

D. The Vendor’s design shall, as applicable, incorporate requirements and features necessary to supply steam to a high pressure steam header that manifolds the supply of steam from four (4) boilers.
E. The manufacturer and proposed equipment shall be approved for installation and operation in The City of New York, and all authorities having jurisdiction.

F. Calibrate all instruments and perform instrument and control loop testing and packaged control loop testing.

G. Install, wire, and commission all instruments, control systems, panels and associated devices.

1.02 WORK INCLUDED

A. The packaged boilers shall be completely shop assembled (taking into account manufacturing and shipping limitations) to constitute a self-contained installation, complete with all accessories and appurtenances for shipment to the site. The Vendor shall state in his proposal what components shall be separately shipped loose for field installation.

B. The scope of work shall cover the supply of two (2) packaged boilers, consisting of, but not limited to, the following major items:

1. (Dual)-drive forced draft (FD) fans consisting of steam turbine drive and electric motor drive for each boiler, including but not limited to inlet hood, ducting, and silencer, control and shut-off dampers, etc. for the supply of combustion air. The forced draft fan performance should match, as close as possible to the conditions of the existing boiler plant, so as to not compromise the performance of the existing boilers and forced draft fans.

2. Supporting steel structure for the complete boiler, including but not limited to drums, FD fan, economizer and other components along with associated platforms, miscellaneous structural steel, operating platforms, ladders, walkways, stairs, handrails, safety cages, etc. Lifting lugs and lifting frames (if required) for shipping, rigging and installation of boiler components.

3. Steam generator complete with evaporator and economizer heating sections, steam and water drums, steam separators, drum internals and supports, tube banks and headers, risers and down comers, tube bank supports, anti-vibration detuning baffles, external trim, feed water piping assembly to economizer and from economizer to evaporation section, etc. Gas tight boiler and economizer casings with insulation (felt, block and tile), refractory block and bricks as required in the burner and furnace area; incorporating openings for burners,
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access and observation doors, etc. Sealing and aspirating air systems, as required, for sealing burners, observation doors, scanner cooling air system, etc., complete with all ducting and piping to the wind box.

4. All air and gas ducts with expansion joints and supports, up to the economizer outlet.

5. Dual fuel register type low NOx burners for natural gas and no. 2 fuel oil firing with all burner-front FM-approved piping and valve trains with atomizing steam system and devices for instrumentation, controls, protection and safety interlocks, etc., including main and pilot gas and fuel oil headers, scanner cooling air header, spark-ignited gas pilots, ignition transformer and flame scanners, etc. NOx emissions shall meet 2014 NYCDEC emissions standards without augmentation to the burner, the boiler, or an SCR system. Currently this requirement is published as 0.15 lbs. of NOx per MMBtu of boiler capacity but NYPH future plans requires this emission value to be 0.08 lbs. The boilers and burners must meet the future requirement of 0.08 lbs. of NOx per MMBtu of boiler capacity without retrofitting or changing, of any components, in the future; on both oil and gas firing.

6. Allen-Bradley or Preferred Utilities burner management system (BMS) for flame monitoring, sequential starting/stopping and safety interlocks for the burner, complete with all sensing devices and local panel, pre-approved by the NYCDEP.

7. Boiler control instruments for control and monitoring of the boiler parameters, including local instruments and control devices and gauges, switches, final control elements, I/P converters, solenoid valves, etc., installed and terminated in local combustion control panel (CCP)/remote panel as applicable. The panel shall be complete with touchscreen activation that allows navigation of all boiler parameters and shall enunciate all alarms. Burner tip nozzle must be stamped for size, oil pump capacities, burner oil delivery rate, lead-lag controller.

All individual components must have name plate reflecting exact make, model, capacity, range, etc. For every component, catalogues must be provided. The fresh air louvers must be mechanically interlocked with the burners. Or if fresh air forced draft fans are used, then the fan must also be interlocked with the burners such that sufficient fresh air is provided into the room when needed. A detailed list is provided in a separate document attached.
All information required to file a NYCDEP application with the Fossil Fuel Division must be provided. At a minimum, this includes over fire draft pressure (in. w.c.), boiler draft losses (in. w.c.), total heating surface area of the burner, combustion controller information such as low-on-off with high start, full modulation, etc., wind box information along with shrouded secondary air damper, pre-purge and post-purge, modulating motor, firing rate controller, rapid-disconnect linkage, automatic pressure device to maintain boiler steam pressure, draft controller, NYC licensed oil burner installer, active insurances, etc.

All controls and instrumentation shall be pre-approved by NYCDEP and as required.

8. The major terminal points of the package boiler supply shall be as follows:

a. Boiler code terminal points shall be set at the feedwater inlet, steam outlet, continuous and intermittent blowdown, etc. in accordance with ASME Boiler and Pressure Vessel Code, Section I for multiple steam generators. This shall include but is not limited piping and the non-return valve and isolation valve at the economizer inlet, stop check and stop valve at the steam outlet, blowdown valves, isolation and non-return valve at the chemical injection lines and others as required. The boiler, burner and all other components identified in the application must bear same exact make and model plates.

b. Single terminal points, approximately 3 feet above the ground floor level, if not accessible by the Vendor’s platforms for each utility and service connection including but not limited to fuel oil, atomizing steam, drains, fuel gas, compressed air, control, power, and others as required.

c. Intake hood of FD fan and outlet of the economizer.

d. Instrument stubs with isolating valves, provisions (i.e. couplings) for temperature measurement, where required.

e. Integral piping and fittings complete with suitable supports, anchors, and guides as required, including feedwater piping assembly.

1.03 WORK PERFORMED BY THE INSTALLING CONTRACTOR
A. The following responsibilities are those of the installing contractor and are intended as general scope outline, not all inclusive:

1. Receive and rig the boiler and its related components into the plant.
   a. The boiler installation including burners, fuel delivery, fans, breeching and exhaust, controls, and all appurtenances shall be accomplished by a contractor licensed by the City of New York for each installation of fuel oil and systems, and boilers.

2. Rough set the boiler and components onto the pad, including but not limited to the following:
   b. Burner
   c. Motor Starter(s)
   d. Control Panel(s)

3. Make the rigging equipment available to the equipment manufacturer for use in final setting of all components.

4. Field wiring:
   a. Field wiring from preassembled skid terminal connection or field-mounted components.
   b. Power supply wiring to motors.
   c. From the FD Fan motor starter to the motor and terminate.
   d. Other Boiler manufacturer required wiring.

5. Foundation.
   a. Installation, including anchor and hold down bolting to the foundation in accordance with Vendor anchor location details.

6. Field installation of loosely-shipped trim, accessories and ancillaries including safety and blow off valves.

7. Piping
a. Natural gas and fuel oil piping to boiler fuel trains.
b. Atomizing steam supply piping from steam header to burner steam train inlet.
c. Vents and drains as required by Boiler manufacturer, design drawings and code.
d. Boiler blowdown
e. Steam Turbine, bearing cooling water piping
f. Steam Turbine, main steam line
g. Service air
h. Instrument air
i. Feedwater
j. Economizer

8. Combustion control system and components, except as noted herein.

9. Insulation and lagging of boiler drum heads and ductwork, if not provided by the Vendor.

10. Safety valve vent stacks, including drip pan elbows and all vent piping to remote location.

11. Field testing and preparations for startup as specified herein.

12. Performance and acceptance testing as specified herein.

13. Utilities, as required and specified by the Vendor, including instrument air, electricity, etc.

14. Provide all labor, tools, and material as required for a complete installation.

1.04 The following responsibilities are those of the boiler manufacturer and are intended as general scope outline, not all inclusive:

1. Supervise the rigging and rough setting of the boilers, auxiliaries and related components. Labor not included.
2. Furnish and install all lubricant and oil piping, electrical wiring, and controls wiring that is required to make the boilers whole and functional that begins and terminates on the boiler.

3. Piping and breeching will be installed by the equipment manufacturer, as required by the contract documents.

4. Field mount the control panels and instrumentation.

5. Wiring from the control panels to the boilers.

6. Provide disassembly of the boilers as required to accommodate rigging.

7. Set the boilers on vibration isolation springs or other supports as specified and level the boilers.

8. Field quality control.


10. Demonstration.

11. Identification Tags.

12. The boiler manufacturer shall certify in writing, completion of the start-up and field testing and make units ready for proper operation. Submit six copies of start-up log.

13. Final alignment of the forced draft fan motor and steam turbine

1.05 UTILITIES AVAILABLE

A. Electricity:  460 V, 3 phase, 60 hz; V, 1 phase, 60 hz

B. Plant Air:  80 psig min., oil free, -40 °F dew point

C. Natural Gas  30 psig

D. Fuel Oil  16 gpm for combustion
1.06 CODES, STANDARDS AND REGULATIONS

A. All materials, design, fabrication, assembly and test procedures shall be in accordance with the requirements of all applicable codes, standards, regulations and authorities having jurisdiction over the work.

B. The organizations having jurisdiction include, but are not limited to, the following:

1) American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section I, Power Boilers and Sections II, VIII and IX.
3) Underwriters Laboratories (UL), UL 795 Commercial-Industrial Gas-Fired Heating Equipment.
5) New York City Department of Environmental Protection (NYCDEP), Engineering Criteria for Fuel Oil Burning Equipment, pursuant to the New York City Air Pollution Control Code section 24-125.
6) Steel Structures Painting Council (SSPC), Surface Preparation Methods.
7) National Electric Code (NEC).
8) National Electrical Manufacturers Association (NEMA).
9) City and State of New York, Department of Labor and Industry Boiler and Inspection Division Code.
10) Occupational Safety and Health Administration (OSHA).
11) Factory Mutual (FM) System.
13) American Welding Society (AWS).
14) American Institute of Steel Construction (AISC).
16) New York State Dept. of Environmental Conservation (NYSDEC)’s 6 NYCRR 227-2 NOx RACT rule.

17) US Environmental Protection Agency (EPA)’s 40 CFR 60 & 40 CFR 63, Subpart JJJ boiler MACT rules.

18) Rules and regulation of the City of New York Department of Buildings.

19) Rules and regulations of Fire Department of New York City.

20) All equipment shall comply with the state, provincial or municipal laws and regulations governing the location where the equipment is to be installed.

C. Reference to any code, standard or regulation shall mean the latest published editions, including addenda, supplements and revisions thereto, which are in effect when the contract is awarded.

D. In the event of conflict between codes, standards or regulations, the conflict shall be referred to the Engineer for resolution.

1.07 INSPECTION

A. The Manufacturer shall provide for inspection and stamping of the equipment in accordance with the requirements of the ASME Code and applicable state and local code requirements. The boiler shall be inspected during construction by the authorized insurance company inspector, and after completion shall be stamped with all identifying markings and symbols as required by the latest edition of the ASME Boiler Construction Code, including but not limited to, National Board (NB) registration and “S” stamp as required by the ASME Code. Stamping shall include National Board number with shop inspection by National Board Inspector.

B. The Engineer reserves the right to inspect the unit during fabrication at the Manufacturer’s plant. Dates and times shall be mutually agreeable to the Manufacturer and the Engineer.

C. Inspection by the Engineer, or lack of, shall in no way relieve the Manufacturer of its responsibility to meet the requirements of the ASME Code, applicable state and local code requirements and this specification.

D. Mill test reports are not required for standard components that are normally carried in inventory, including bulk raw material.
E. Pressure-containing parts shall not be painted until the specified inspection of the parts is completed.

Steam Turbine

A. During assembly of the equipment and before testing, each component (including cast-in passages of these components) and all piping and appurtenances shall be cleaned chemically, or by another appropriate method, to remove foreign materials, corrosion products, and mill scale.

1.08 SHOP TESTING

A. All equipment and material shall be subject to the Manufacturer's standard shop tests in accordance with the applicable codes and this specification. Tests shall be carried out at the Manufacturer's facility during and after completion of the manufacture of component parts in accordance with requirement of ANSI/ASME Boiler and Pressure Vessel Code. Wherever not specified in the said regulations, the tests shall be carried out in accordance with the standards proposed by the Vendor and approved by the Engineer.

B. The Vendor shall specify that all shop tests to be performed comply with applicable requirements. The Vendor shall notify the Engineer no later than 5 working days prior to any testing, so that the Engineer may witness the testing.

C. Boiler: At a minimum, the following shop tests shall be performed:

1. Hydrostatic pressure test of all pressure parts, piping, and valves in accordance with the ASME code.

2. All pressure-retaining finished welds shall be inspected using a non-destructive examination, as applicable by code for materials and welds, including 10% randomly tested by radiography for natural gas piping systems only.

3. Calibration tests of standard orifices, nozzles, instruments, and control equipment.

4. The boiler and economizer casings shall be factory tested for tightness in accordance with ASME Code requirements.

5. Each control panel shall be factory tested by the Vendor in accordance with the Vendor's standard test procedures for simulation of the control panel BMS.
logic sequence, flame detectors, etc. and to assure that the wiring of components are in accordance with the Vendor’s wiring diagrams.

6. Leak testing of control valves as per ANSI.

7. Functional tests on all solenoid, motor operated and pneumatically actuated valves and control valves.

9. Leak testing of all gas and air piping systems in accordance with NFPA, ASME, etc.

9. Any other tests deemed necessary by the Vendor and inspecting authority.

D. **Steam Turbine**: At a minimum, the following shop tests shall be performed:

1. **Hydrostatic Test**

   a. Pressure-containing parts (including auxiliaries) shall be tested hydrostatically with liquid at a minimum of 1.5 times the maximum allowable working pressure but not less than a gauge pressure of 1.5 bar (20 pounds per square inch gauge). The test liquid shall be at a higher temperature than the nil-ductility transition temperature of the material being tested.

   Note - The nil-ductility temperature is the highest temperature at which a material experiences complete brittle fracture without appreciable plastic deformation.

2. When non-contacting probes are not provided and when vibration cannot be measured on the shaft, radial vibration of the housings shall be recorded using shop instrumentation during the test. The measurements shall be taken on the top and side of each bearing housing,

3. The vibration characteristics determined by the use of the instrumentation specified in Item 2 above.

4. Turbines shall be given a 1-hour uninterrupted no-load running test at maximum continuous speed.
5. Unless otherwise specified, the control system shall be demonstrated and the mechanical running test of the steam turbine shall be conducted.

6. Steam conditions shall meet design operating conditions.

Note - Due to no-load operation for extended periods of time during the test, the inlet steam conditions may need to be reduced to prevent overheating of the unit and exceeding design clearances.

7. The speed shall be increased to 110 percent of the maximum continuous speed, and the equipment shall be run for a minimum of 15 minutes at the increased speed.

8. Vibration readings shall be taken at maximum continuous speed, just below trip speed, and at minimum operating speed after the stabilization. Any critical speeds below maximum continuous shall be determined. Vibration limits for operation just below trip speed for turbines are 1.5 times the turbines stated values.

9. Overspeed trip devices shall be checked and adjusted until three consecutive non-trending trip values within ±2 percent of the nominal trip setting are attained.

10. The speed governor and any other speed-regulating devices shall be tested for smooth performance over the operating speed range. No-load stability and response to the control signal shall be checked.

11. When spare rotors are ordered to permit concurrent manufacture, each spare rotor shall be given a mechanical running test in accordance with the requirements of this specification.

E. The Vendor shall make all necessary adjustments or modifications required if shop and/or field testing identifies performance or design deficiencies.

F. Certified copies of all shop and field tests and examinations performed by the Vendor shall be provided to the Engineer for record purposes. All test reports shall be countersigned by the inspecting authority where required by code.

1.09 FIELD TESTING AND PREPARATION FOR STARTUP
A. The Manufacturer shall submit procedures for field testing of items not covered by shop testing. Tests shall be conducted in conjunction with the Vendor’s authorized representative.

B. After installation at site, the equipment shall be subjected to various site tests by the Engineer to demonstrate their soundness and general conformance to the specifications. This shall include the following as a minimum, as performed by the Installing Contractor:

1. Hydrotest of the complete assembly in accordance with applicable Codes.
2. The complete enclosure including ductwork shall be field tested for gas tightness. Suitable test procedure for this shall be provided by the Vendor for approval by the Engineer.

C. The Vendor shall provide performance testing of the boiler during startup service to ensure the ability of the equipment to comply with performance guarantees. Independent testing of the boiler shall be done by others to ensure compliance with the Vendor’s performance guarantees in accordance with this specification.

D. Chemical cleaning (i.e. boilout) of the boiler steam and feedwater path shall be performed. The Vendor shall provide recommendations for this cleaning procedure. In addition, the Vendor shall provide an optional price with his proposal to provide complete cleaning services to make the boiler ready for operation, including, but not limited to, supply of chemicals, disposal of waste water, flushing of system, etc. Chemical cleaning supply and disposal by installing Contractor

1.10 PERFORMANCE & ACCEPTANCE TESTING

A. Acceptance of the boiler system by the Engineer shall be subject to a formal Performance and Acceptance (P&A) test at site in accordance with ASME Performance Test Codes, PTC 4.1, Abbreviated Heat Loss Method, latest editions or any equivalent thereof. The detailed test procedures shall be prepared and submitted by the Vendor for review and approval by the Engineer.

The Vendor shall identify and provide all taps required in the Vendor’s piping or equipment necessary to perform this testing. Additionally, the Vendor shall identify any special requirements, such as highly accurate flow nozzles, for this testing that need to be incorporated into the Engineer’s piping system design.

B. Sufficient tests shall be run to determine actual efficiencies of the unit under all guaranteed conditions. Requirement of the number of test runs and their duration shall
have to be agreed with the Engineer before conducting the tests. Such tests shall be conducted under conditions maintained as close to contract conditions as plant operations permit. Curves, which the Vendor shall submit as part of his proposal, shall be used where necessary to correct variations in ambient temperature, fuel heating value, etc. The Vendor’s service engineer(s) shall be present during the tests. Certified copies of all test data shall be submitted to the Engineer at completion of the tests.

Boiler/burner thermal efficiency test as per ASME standards. Test must be witnessed by a licensed Professional Engineer and the report must bear engineer’s seal and signature. This report shall be submitted to the Owner/Engineer upon completion of construction. Necessary notification to the NYCDEP shall need to be made. All expenses are the responsibility of the Contractor.

C. The Vendor shall furnish all connections and instruments necessary for conducting the tests. The Owner shall furnish water, power, and similar items incidental to the operation of the equipment, including regular station personnel.

D. All the above tests shall be performed by others at the time of plant commissioning. In case these tests reveal any discrepancies of Vendor’s equipment, the Vendor shall be required to rectify the same promptly and at his expense, so that they can be accepted by the Engineer. The boilers must meet and successfully pass NYCDEP’s initial performance test criteria as identified in the NYCDEP’s manual. A completed test report must be provided prior to NYCDEP inspection. Installer must ensure successful passing of the NYCDEP inspection and only then turnover the boilers/burners to the facility.

1.11 SUBSTITUTIONS

Any proposed substitution must be provided with the bid.

No substitute material or manufacturer of equipment shall be permitted without a formal written submittal to the Engineer which includes all dimensional, performance and material specifications and is, approved in writing by the engineer.

Any changes in layout or design brought about by the use of a substitution shall be submitted to the engineer fully designed for review in conjunction with the submittal of the alternate. Any substitution must be submitted with an explanation why a substitution is being proposed. If the substitute is being utilized for financial reasons, the associated credit must be simultaneously submitted.
Final acceptance or rejection of any substitution is subject to the Owner’s review.

1.12 SUBMITTALS REQUIRED WITH EACH PROPOSAL

Failure to submit any of the following information may be cause for rejection of proposal.

A. Total net pricing (FOB site), estimated freight costs broken out and proposal validity date.

B. Alternate proposals and optional quotes, as specified herein.

C. Complete project schedule, including, but not limited to approval drawing submittal delivery after order; finalization of detail engineering, release for manufacturing, equipment delivery to jobsite after approval of drawings.

All deliveries to be quoted as the best achievable. In order to achieve this delivery date, if needed, the Vendor shall specify latest P.O. release, early release requirements for long-lead materials or components, etc.

D. For each guarantee condition, the Vendor shall provide complete boiler design and performance data, including design pressures and temperatures, boiler pinch and approach points, fouling factors, stack temperature, heat duties, flowrates for gas side, steam and feedwater, associated pressures and temperatures, etc.

E. Guaranteed burner emissions performance from specified minimum load to full-fire for operation with natural gas and no. 2 fuel oil. Emissions shall be stated in lb./mmBTU (HHV) for NOx, CO, UHC, NMHC, PM-10, TSP and opacity based on EPA Reference Test Methods.

F. An ASME Efficiency Test Report sealed and signed by a professional engineer must be provided for an identical boiler configuration. Contractor must ensure that the report is approved by NYCDEP.

G. Completed data sheets.

H. Technical clarifications and exceptions to the specification.

I. Scope of supply, including materials of construction, component listing identifying the manufacturer of the burner, specialty valves and components and all work by others.
The Vendor shall state in his proposal what components shall be separately shipped loose for field installation.

J. The following information shall be provided: general arrangement drawings (plan and elevation views), P&ID, preliminary foundation drawing(s), shipping and operating weights of major components, and space requirements for erection and maintenance.

K. Utility and fuel requirements, including but not limited to electrical requirements, flow rates for compressed air, natural gas, and fuel oil.

L. The Vendor shall provide a complete and detailed description and design features of the boiler system including construction, controls (identifying all local and remote control devices), and safety precautions. The Vendor shall discuss what design considerations are provided to permit rapid startup (identifying expected time to high fire) and limitations of loading rate, such as lower drum coils per section 2.03 (C). The Vendor shall provide a summary of their boiler’s design features and their associated competitive advantage(s). The Vendor shall provide details and thickness of refractory and insulation for the entire boiler.

M. The Vendor shall include an experience (or application) listings of projects operating with the same type of boiler as proposed for this project; the listing shall identify the heat source (i.e. steam turbine supplier and model). The Vendor shall also provide for the same type of boiler, as a minimum, two complete references for contact by the Engineer, including company, individual and phone number.

N. The Vendor shall identify specific design ideas that shall minimize field installation work and overall project cost that is not specified herein.

O. The Vendor shall provide detailed information regarding his ability to service the boiler system both during startup and subsequent operation. The information shall, as a minimum, include the following: is the service organization part of corporate group or done through agents, are service personnel specialized in particular type of equipment (i.e. watertube vs. firetube boiler), how many field service personnel are there and what is their geographical dispersion (both nationally and specifically in proximity to this site), does a single service person cover all disciplines or are they specialized in mechanical or controls, etc.

P. Curves: The Vendor shall provide steam flow versus power for various settings of the hand valve or valves, for the steam turbines, when the turbines are operating at normal speed.
Q. Any other technical data requested in this specification not specifically mentioned above.

R. Size and weight of all rigging components and a drawing showing the overall size and configuration of the fully assembled boiler.

1.13 SUBMITTALS REQUIRED AFTER PURCHASE ORDER

A. All non-proprietary design drawings, calculations, operating and maintenance manuals, data sheets, etc., as a minimum, shall be submitted in accordance with the attached Vendor Data Requirements form for review and approval and final certification as required. The Vendor shall submit an initial drawing schedule, identifying drawing titles and numbers within two (2) weeks of issuance of the purchase order. All submittals shall be submitted to the Project Manager as follows:

1. For Approval - 1 reproducible and 6 legible prints (reproducible of sizes larger than 11” x 17” to be provided on bond plotter paper) including diskette(s) containing general arrangement drawings, as required for plant layout of equipment, in latest AutoCAD or Revit.

2. After Final Approval - 1 certified reproducible set (reproducible of sizes larger than 11” x 17” to be provided on bond plotter paper) including diskette(s) containing general arrangement drawings, as required for plant layout of equipment, in latest AutoCAD or Revit.

3. Operating and Maintenance Manuals - 12 sets

4. All Vendor drawings shall have the project name (“New York Presbyterian Hospital Boiler 4 and 5 Replacement”), Engineer’s name (“AKF”), in the drawing title.

5. Drawings shall be submitted for approval prior to fabrication of the equipment or development of software. Unless otherwise identified in writing in the purchase order, fabrication shall not commence until these drawings are returned “Proceed” or “Proceed as Noted.” Drawings shall show, as a minimum, the following:

   a. Information specified by the Engineer.
   b. Certified dimensions.
c. Construction specifications.

d. Specification for gaskets and bolts.

e. All materials of construction.

f. Rigging Drawings

On or before one month prior to equipment shipment, the Vendor shall identify all spare parts, including source, cost and identification of the manufacturer and associated model number, critical to initial startup that are recommended for the Engineer/Owner to have on-hand to minimize unplanned construction delays or equipment downtime, as well as a standard priced spare parts list for replacement of components as needed. The Vendor shall recommend spare parts expected for replacement during two (2) years of operation.

B. Submittal Schedule

1. Documents for Review:

   g. Equipment Arrangement Drawings – 20 Days ARO

   h. Catalog Cuts of all Components – 20 Days ARO

   i. Piping and Instrumentation Diagrams – 20 Days ARO

   j. Electrical Schematics – 20 Days ARO

   k. Wiring Diagrams – 20 Days ARO

   l. Permit Applications for Local, State, Federal Requirements – 30 Days ARO

   m. Equipment Data Sheets – 30 Days ARO

   n. Instrumentation Installation Details for all Field Mounted Items – 30 Days ARO

   o. Handling and Storage Instructions – 30 Days Prior to Shipment

   p. Installation and Startup Instructions – 30 Days Prior to Shipment

   q. Welding Reports (Including ASME/NBIC Data Reports)

   r. Notification of Shop Testing Schedule – 15 Days Prior to Test

   s. Certified Test Reports – 10 Days After Test Completion

   t. Field Test Procedures – 20 Days Prior to Shipment

   u. Training Schedule – 30 Days Prior to Shipment
C. Drawing Requirements (not all inclusive):

1. Final equipment layouts shall include arrangement drawings in plan and elevation, with all major components identified. Product and service tie-ins shall be identified by size, type and dimensions for locating tie-ins. Access clearances for service of equipment and removal of components shall also be shown. Mechanical interfaces to other systems or utilities shall be clearly identified and dimensioned, including size and type of connection. Detailed location and characteristics of all terminal points, including but not limited to electric power connection requirements, control interfaces, emission monitoring, shall be provided.

14. Elevations and sections shall be provided as necessary to show full details of tie-ins, service access and control components.

15. Overall dimensions and detailed floor loadings shall be shown.

16. Drawings shall be in accordance with ASME Y14.2.

1.14 SOUND AND VIBRATION

A. It is the Owner’s intention to have the area where this equipment shall be operated not requiring hearing protection as defined by OSHA. The Vendor shall make every effort to design and manufacture the equipment in a manner such that sound and vibration generation is held to a minimum.

B. All equipment furnished by the Vendor in accordance with this specification shall not produce a cumulative sound level in excess of 85 dba at 3 feet from its external surface as measured in accordance with ANSI Standards S1.2, “Method for the Physical Measurement of Sound” and S 1.4, “Specification for General Purpose Sound Level Meter”.

C. If any equipment, including accessories, furnished in accordance with this specification shall, under normal operating conditions or under operating conditions specified produce either an individual or cumulative sound pressure level in excess of 85 dba, the Vendor shall state the sound level in their proposal as a condition of the sale for the equipment. If described level exceeds 85 dba, the Vendor shall quote a noise suppression kit or enclosure to bring noise level into compliance.
1.15 SAFETY

A. All mechanical equipment shall be fully guarded and interlocked with machine operations; i.e., exposed gears, chains, belts, sprockets and hazardous moving parts to meet current OSHA standards in effect at the time of delivery. Guard doors shall include electrical interlocks to stop or prevent machine operation if the guard door is opened. In order to comply with OSHA requirements for lockout/tagout, padlockable devices shall be provided to isolate and safely release electrical, pneumatic and other potential sources of energy release.

B. The Vendor shall warrant that all equipment complies with the appropriate standards for machine guarding and design set out in United States Code of Federal Regulations (CFR) Title 29, Chapter XVII, Part 1910, Subpart O.

1.16 COMMISSIONING (Cx) AND TRAINING

The Vendor shall provide the necessary field startup services to fully commission the equipment to achieve performance guarantees. This service shall include, but not be limited to, verification of proper installation, performance of all tests and procedures as stated in the startup and installation manuals, verification of the proper operation of the control panels to perform as designed, performance of all necessary adjustments and calibrations of all unit sensors and meters and necessary technical assistance to assure that the Vendor’s equipment meets the performance guarantees. The Vendor shall make all reasonable attempts to insure that the same service technician is utilized for startup, training and commissioning for each of the Vendor’s equipment packages (i.e. boiler and burner) for the duration of the project.

A. Process

The commissioning process shall include (but not be limited to) the activities listed below:

Pre-construction phase – Project is being awarded to sub-contractors and design is complete.

1. Visit and become familiar with the site and project scope as relating to MEP systems and equipment.

2. Document the owner’s project requirements for the project and document the basis of design.
3. Complete a thorough review of the CD documents, finalize the specific systems and equipment to be commissioned and submit comments to the Engineer of Record for review and comment.

4. Develop commissioning specifications for all equipment and systems to be commissioned for inclusion in the contractor’s scope and responsibilities.

5. Develop a project specific commissioning plan reflecting the construction and occupancy phases and includes:
   - Brief overview of commissioning process
   - Identification of primary Cx participants and their responsibilities
   - Description of the management of the Cx Plan
   - Outline of the Cx process (submittal review, observations, start-up, testing, training and O&M manual submission).

Construction phase

1. Organize and direct Cx activities.

2. Provide factory witness testing, if necessary and requested by owner.

3. Participate in the submittal review process for equipment to be commissioned. 2 sets of the O&M manuals are to be provided to the Office of Facilities Operations (OFO) through the Cx 45 days after approval of the submittal.

4. Perform site visits, as necessary, to observe component and system installations to ensure conformance to the OPR and design intent. Attend selected job meetings to follow construction progress, identify issues and discrepancies and assist in resolution of discrepancies.

5. Organize and conduct periodic Cx team meetings to coordinate activities and resolve problems.

6. Develop the pre-installation checklists that outline the equipment covered and will itemize key specifications and installation requirements. Verify that equipment is installed in accordance with plans and specs through routine site visits.
7. Develop and write pre-startup testing checklists for all equipment and/or systems to be commissioned. Submit to owner for approval. Once approved, provide these to contractors for their information. Perform inspections and witness tests and document same.

8. Develop Functional Test procedures that include all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal and emergency conditions under all operating conditions. Witness the functional test and document results. Test procedure must include maximum load test and efficiency determination.

9. Facilitate OFD-E and OFO participation in special inspections and tests as required.

10. Witness duct leakage testing as required.

11. Assist the contractor in developing logical and adequate flushing and cleaning plans for steam and condensate piping systems. Witness flushing and cleaning of piping systems.

12. Participate in the functional testing and commissioning of each system.
   - Verify the system and its components are installed with adequate maintenance accessibility.
   - Ensure that all new equipment is installed according to Manufacturers specifications
   - Ensure that warranty provisions are maintained with regards to all equipment installation.
   - Participate in the testing of all system functions.
   - Participate in the testing of all system controls and safeties.
   - Document all issues.
   - Document, separately, all issues that cannot be corrected within the project scope.

13. Maintain a real time issues log showing all of the identified items and status of the corrective action.

14. Generate and issue periodic commissioning reports in accordance with the commissioning plan.
15. Review the project O&M manuals. Verify manuals are comprehensive and project specific and ensure distribution to Operations Staff.

16. Assist the contractor with organizing and conducting Owner training sessions in accordance with the specifications. Review curriculum submitted by vendors for appropriateness. Ensure that training includes component training, system training and integrated systems training. Track attendance of operations staff at scheduled training sessions.

17. The Cx shall oversee the training of Owner’s personnel for commissioned equipment and systems. The Cx will develop plant operations training program to incorporate all new equipment into general plant operations course. 3 classes must be worked into scope, one for each shift. The Cx shall interview the Owner’s staff to determine the special needs and areas where training will be most valuable. The Cx shall communicate the results to the CM for implementation. The CM and/or contractors will submit one comprehensive training plan to the Cx and Owner.

The plan will be reviewed by the Cx and Owner. Comments pertaining to its deficiencies will be forwarded to the CM and Contractors.

TRAINING
The Vendor shall provide on-site training for up to 25 operating and maintenance personnel. This service shall include operating instructions and training for Owner’s personnel. Instructions shall include, but not be limited to, training materials, hands-on and classroom instruction and complete review of all manuals. Classroom training shall be performed for two groups of personnel in a maximum of 8-hour daily sessions. The hands-on instructions shall include start-up, operation (normal and expected transients), shutdown and maintenance of all boiler systems.

The training plan will be rewritten until approved by the Cx and Owner. The final approved training plan will cover the following elements:

- Equipment (included in training)
- Intended audience
- Location of training
- Objectives
- Subjects covered (description, duration of discussion, special methods, etc.)
- Duration of training on each subject
- Qualified instructor for each subject
• Instructor qualifications
• Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)

Topics to include but are not limited to:

• Boiler Plant equipment sequencing
• Incorporate new Boiler performance into sequence
• Boiler Operations -
• Operator equipment protocols
• Develop operator startup procedures for all equipment within the scope of the project.
• Develop shutdown procedures for all equipment within the scope of the project.
• Preventative Maintenance
• discuss pm plan to operators and repair shop
• correlate routine maintenance on all equipment

Training documentation shall include the following items:

• Copy of the training plan, including schedule, syllabus, and agenda.
• Copy of the Owner’s Program Requirements.
• Copy of the Basis of Design.
• Compiled operations manuals.
• Compiled maintenance manuals.
• Completed manufacturer training manuals.
• Red-lined drawings.
• Other pertinent documents.

The Cx develops criteria for determining that the training was satisfactorily completed, including attending some of the training, etc. The Cx recommends approval of the training to the Owner using a standard form. The owner signs the approval form/letter template.

Post Acceptance Phase

1. Schedule seasonal testing.

2. Based on full load performance data, modify plant operating procedures to incorporate new boilers.

3. Analyze functional performance trend logs and monitoring data.
4. Review final commissioning manual and verify that all commissioning requirements have been met. Ensure that the owner is apprised of the status of all identified commissioning issues.

5. Generate a final Commissioning Report in accordance with the commissioning plan.

6. Return to the site at 10 months into the warranty period to assess outstanding warranty issues and identify areas that need to be addressed under the warranty.

7. Participate in any required regulatory inspection and assist NYPH in assembling of required documents for systems commissioned.

8. Assist OFO is cataloging and tagging all new equipment with NYPH asset tags and ensure that OFO has a complete listing of all new equipment installed in the project.

9. Provide a detailed Preventive Maintenance Plan for all newly installed equipment to OFO based on manufacturers recommendations in the required format (to be provided by OFO).

10. Coordinate meetings with OFD-E and OFO to facilitate turnover of documents as per specifications.

1.17 PERFORMANCE GUARANTEES

A. The Vendor shall guarantee that steam after the evaporator outlet shall contain no more than 0.5% moisture when the total solids concentration of the feedwater is maintained in accordance with ABMA recommended standards. These standards shall be submitted by the Vendor for the Engineer’s review and use.

B. The Vendor shall guarantee the steam generating capacity of 120,000 lbs./hr. for steam pressures of 125 to 150 psig at the discharge of the steam drum second isolation valve, feedwater temperature to the economizer inlet of 228°F, and a continuous surface blowdown of 3% when firing natural gas or when firing no. 2 fuel oil based on operating with indoor ambient temperature of 80°F.

C. The Vendor shall provide guaranteed burner maximum heat duty, turndown ratios when firing either natural gas no. 2 fuel oil, and both emissions and opacity occurring
simultaneously from no less than 10% to 100% of boiler load. In addition, the burner shall maintain a stable flame with no deleterious impingement on the boiler system over the entire burner turndown range.

D. The Vendor shall identify all additional performance guarantees available, including, but not limited to, boiler thermal efficiency at MCR, steam pressure, steam temperature, sound level, casing temperature, etc. in accordance with performance and design requirements of this specification, as applicable.

1.18 WARRANTY

B. Goods: Vendor warrants against defects on all goods manufactured for a period of one (1) year from date of startup or use, or eighteen (18) months from date of shipment, whichever comes first.

C. Services: Vendor warrants against defects in workmanship on all services performed by pump and turbine manufacturer for a period of ninety (90) days from date of completion of such services. Vendor’s obligation to repair or replace any defective goods or re-perform any defective services during the warranty period shall be Owner’s exclusive remedy and Vendor’s sole liability arising under this warranty or any warranty Claim made by Owner.

This warranty is given in lieu of all other warranties, expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose. Vendor shall not be responsible for labor or other charges resulting from removal or reinstallation of defective goods or for re-performance of defective workmanship, charges for transportation, handling, shipping or travel. None of the goods furnished by Vendor shall be deemed defective by reason of failure to resist the action of erosive or corrosive gases or liquids or the deposition of foreign material from such gases or liquids.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Boilers:
   1. Babcock & Wilcox (B&W).
   2. Cleaver Brooks, (Nebraska Boiler)
   3. Rentech Boilers.
B. Burners:
   1. Coen
   2. Natcom
   3. Powerflame

C. Combustion Controllers:
   1. Preferred Utilities.
   2. ABB.
   3. Foxboro.
   4. Allen Bradley

D. Steam Turbines:
   1. Elliot.
   3. Dresser-Rand
   4. Coppus Turbine

E. Electrical Motors:
   1. General Electric.
   2. Westinghouse.
   3. US Motors

F. Motor Controllers:
   1. Emerson
   2. ABB
   3. Square D (a Div. of Schneider Electric)

2.02 GENERAL DESIGN

A. Detail design of the entire boiler system shall be the responsibility of the Vendor.

If a radiant furnace is selected, the design shall employ a minimum amount of high temperature refractory to reduce the thermal inertia of the boiler. The radiant zone shall comprise of gas tight waterwall construction with a minimum of membrane type waterwall tubing and refractory construction, which shall also ensure gas leak tight furnace, designed to withstand high furnace design pressure or vacuum.

The difference of the temperature of the boiler exit gas from the saturation temperature of steam in the evaporation zone (which is defined as pinch point) shall be carefully chosen to result in an optimum design of the overall boiler. The Vendor shall provide
details of calculations of the pinch point at the design condition. Similarly, the
difference of evaporator saturation temperature and temperature of feedwater inlet to
the evaporative drum (which is defined as economizer approach) shall be optimized.

B. The boiler shall be of the two drum, “D” type frame water tube integral furnace type, with
the furnace rear walls, side walls, roof and floor all water cooled. Both furnace
sidewalls, roof and furnace rear wall must be totally water-cooled. "Totally" water-cooled
is intended to mean flat studded tube or membrane wall type construction covering the
entire surface area. No refractory shall be permitted on the furnace side or rear walls.

C. For those boilers using flat studded tubes, the tube thickness must be a minimum of 0.134"
thick. For those boilers using membrane wall design, the furnace tubes shall be arranged
so that the membrane bar between each tube shall be no greater than 1" in width and
1/4" thick. Minimum tube thickness for membrane design is to be 0.134". The boiler
baffle or furnace division wall, regardless of the boiler tube wall construction, shall be the
membrane type to prevent bypassing of flue gas.

The heating surface, per ABMA definition, shall not be less than:
Convection (boiler) heating ................................................... 5787 FT²
Furnace heating surface (flat projected)................................. 894 FT²
Total boiler heating surface ................................................... 6681 FT²
Furnace volume ................................................................... 1368 FT³

D. Boilers shall be designed with a minimum of refractory. All water wall tubes shall go
directly from the lower drum into the upper steam drum. All tubes shall not be less than
2.0" OD and shall be constructed in accordance with ASME Boiler Code. To insure
positive circulation, all downcomer tubes must be located in the coolest gas area or
protected from the flow of combustion gases. Boilers using headers are not acceptable.

E. The steam generator and all pressure-retaining components shall be designed,
fabricated, examined, inspected, and tested in accordance with Section I - Boiler and
Pressure Vessels, Section II - Material Specifications, and Section IX - Welding and
Brazing Qualifications of the ASME Boiler and Pressure Vessel Code.

F. The boiler system, including all applicable piping systems, shall be designed in
accordance with ASME Boiler Code Section I and as follows:

1. All drum and other connections required for proper operation shall be provided.
2. ANSI 300 lb. rated system connections shall be flanged, except for
connection sizes 2” and smaller shall be either threaded or socket weld union-end, as required by applicable codes.

3. The boiler system weight shall be uniformly distributed to the maximum extent possible. The boiler section base shall be constructed of welded structural shapes of standard construction.

G. The boiler shall be located indoors at an approximate elevation of 0 feet above as level.

H. The boiler shall utilize low NOx burner technology and have evaporator and economizer sections. There shall be no superheater.

I. The boiler shall be of the wetback watertube type, working on the principle of natural circulation.

J. The boiler design shall provide good access inside. Good maintenance aisles shall be provided to gain access to the heat transfer tubes, so that tube elements may be removed, repaired or plugged.

K. The boiler shall be designed to withstand rapid start up, sudden load swings and shutdown including thermal shock without inducing injurious expansion stresses or temperatures above that for which the materials are selected.

L. For better quality control, emphasis shall be given on maximization of shop assembled modular construction, with all welded features for pressure parts, tube banks, tube supports, stub connections into the drum, etc. Site fabrication work shall be minimized. The design emphasis of the boiler should be on high reliability and simplicity.

M. The boiler shall be designed to provide ample evaporating tube surface for the maximum capacities specified and a sufficient number and size of unheated downcomers to assure proper circulation in all parts of the boiler, even under rapid start-up conditions.

N. All equipment, ductwork, etc. provided by the Vendor shall be so designed to meet OSHA guidelines and ensure that a maximum casing surface temperature of 140°F, considering a still surrounding air temperature of 90°F, is not exceeded under any load conditions and also to prevent the formation of condensed moisture or “sweat”. Insulation at equipment openings and flanged joints shall be finished off with metal
edges to allow removal of cover and joint bolts so that the equipment can be opened for access and servicing without damage to the insulation.

O. All equipment furnished by the Vendor shall be ready for field assembly. This includes, but is not limited to, matching marking of components (such as fan damper linkages, feedwater piping, positioners, etc.).

P. Materials

1. The Vendor shall indicate on his approval prints, what ASME or ASTM specification grade number he shall be furnishing for materials specified. Material shall be Vendor’s standard for the application or as specified herein.

2. Nozzle, nozzle reinforcement plates and fittings shall be constructed of the same materials as the component which they are attached to.

3. No asbestos or asbestos bearing materials are permitted.

4. Materials not specifically specified herein shall be of the best commercial quality. All materials shall be free from defects that might affect its performance or serviceability.

2.03 DETAIL DESIGN

A. The boiler shall not generate less than 120,000 lbs./hr. of dry saturated steam at any pressure from 125 psig to 150 psig at the discharge of the steam drum second isolation valve when operating at its maximum continuous rating (MCR) with either specified fuel. Since the maximum expected operating pressure shall generate steam at 150 psig as above. Therefore, the design pressure of the pressure-retaining components for steam production shall not be less than 250 psig.

B. The design for the boiler shall be developed on the basis of natural circulation only, i.e., it shall not rely on circulation pumps either in part (assisted circulation) or completely (forced circulation) to promote fluid flow through the hot tube path. The boiler shall meet the following criteria:

1. The boiler shall be of the two-drum, watertube, integral-furnace type with water-cooling for radiant surfaces, such as the furnace front and rear walls, sidewalls, roof and floor to assure the reduction of furnace exit gas temperature to a maximum of 2100°F prior to entry into the convection zone. Both furnace...
sidewalls and the furnace rear wall shall be totally water-cooled. No part of the boiler drums shall be directly exposed to furnace radiation. Water-cooled surface covered with refractory shall not be utilized in the calculation of the radiant heating surface.

2. Waterwalls shall extend the full length of the furnace setting and shall consist of 2" minimum diameter steel tubes. All furnace waterwall tubes shall enter the steam drum below the normal operating drum level and the lower drum above the horizontal drum centerline. The design shall provide for tube seat inspection ports in the furnace to boiler division wall, along both the steam and mud drums.

3. The waterwall surface shall be computed on the basis of the sum of the flat projected areas of the tubes and the extended metallic surface on the furnace side in accordance with ABMA standards. Only the surface below the normal water line, and exposed to radiant and convected heat from the furnace shall be considered in the total heating surface.

4. The furnace design shall be of the proper proportions for burning either no. 2 fuel oil or natural gas with complete combustion permitting long flame travel but without flame impingement on any part of the furnace for any load condition.

5. Baffles, if required, shall be arranged as required to diffuse the gas properly over the heating surfaces, to obtain maximum heat absorption and to prevent short circuiting of flue gas flow, and shall be held securely in place without being affected by or interfering with the free expansion or contraction of the boiler. The baffles shall be constructed of not less than 1/4" steel, or if heat resistant alloy of not less than 1/8" nominal thickness. Baffles shall be capable of withstanding the existing temperature under maximum load conditions.

C. Drums:

1. The boilers shall be of the two-drum “D” type design, with the drums extending beyond the entire length of the furnace setting. Drum shall be fusion welded, stress relieved and radiographed and constructed of steel plates as per applicable codes of ASME Boiler and Pressure Vessel Code with material properly selected for operation conditions. No part of the boiler drums shall be directly exposed to furnace radiation.
2. Steam drum is to provide satisfactory steam/water separation, steam drying and maintaining the quality of outlet steam within the specified limits under all operating conditions.

3. An elliptical manhole in each head of each drum and forged steel bolted manhole cover plate and forged steel yokes, with suitable gasket for each manhole opening shall be provided, along with insulation curbs for each manhole. The minimum size of the manhole clear opening shall be 18" x 16" (provided that this requirement does not cause an increase in drum size).

4. Furnish and install suitable internals for feedwater distribution, chemical feed and continuous blowdown in the steam drum. Maintain a stable water level under a fluctuating load. Furnish and install suitable dry pipe or separating device in the steam drum under the main steam outlet to separate entrained moisture from the steam to assure delivery of steam with moisture content not in excess of 1/2 of 1% concentration when boiler concentrations are maintained in accordance with ABMA recommendations. The drum internals along with steam separating device shall direct the flow of steam and water so as to obtain an optimum distribution of drum metal temperature over the entire operating range. The internals and the separator used shall be of low-loss type. The arrangement and fabrication of the drum internals shall permit easy removal and replacement through drum manholes. The feedwater piping from the economizer entering the drum shall be spaced suitably so that there is no uneven distribution of flow over the entire length of the drum. Chemical feed and continuous blowdown connections shall be located on opposite ends of the drum.

5. The drum shall be sized to hold 2 minutes storage (at MCR) of water inventory between the low water alarm and low-low water trip levels and this storage capacity shall be indicated in the bid. The calculation of holding capability shall include the effects of sizing the drum intervals and no quenching action of incoming feedwater, assuming that the supply of the same has been completely cut off. The steam drum shall have adequate freeboard space to accommodate the swelling of water during start up, without flooding drum internals. At startup or during loss of steam load, no carryover of water droplets along with generated steam is permitted. Water surge volume in steam drum shall be adequate to accommodate the swelling or shrinkage, resulting from a change in steam load of 20% of boiler maximum continuous rating in one (1) minute, without any water carryover or actuating high/low level alarms, or trips.
6. Provisions for an adequate number of level and pressure instruments shall be provided. One set of tapping points with condensing vessels (seal pots), valves, etc. at both ends of the steam drum shall be provided for remote level control and measurement purposes in addition of the tapping points for one local level gauge. Provision shall also be made with T-off or by independent taps for level switches for alarm, drum high level and low level and low-low-line level. Independent taps for remote drum pressure control and measurement shall be provided on the steam piping. All nozzles shall be welded to the drum and headers and shall extend through the insulation where applicable. The drum shall have sufficient number of nozzles for drum auxiliaries, drain, vent, blowdown, air release, feedwater, chemical feed, steam safety valves, instruments, sampling connections, etc. as necessary.

7. The boiler drums shall be fusion welded of ASME specification steel and shall be manufactured in strict accordance with the ASME Boiler Code, including stress relieving and x-raying of welded seams as required by code. Provide both drums at both ends with double isolation valves, plugged or capped connections for drainage by gravity.

8. The mud (lower) drum shall be provided with steam heating coils and associated controls, as required, to reduce startup time to reach high fire. The desired rapid startup time shall be less than 1 hour. The Vendor shall provide expected time to reach high fire and steam flow rate to maintain the required temperature.

D. Tubes:

1. All boiler tubes shall not be less than 2" in diameter and 0.134” wall thickness, seamless in accordance with the material requirements of ASME Section II. A. All tubes shall be designed and arranged to provide for natural circulation in the proper direction at all loads.

2. The tubes shall be bent to a true radius by use of a mandrel inserted during bending to prevent distortion at the bend. Tubes that are distorted in bending, flattened or ridged shall not be accepted. The design of the tubes shall permit both drums and all tubes to drain by gravity. The design and radii of all bends in tubes shall be such that a conventional type cleaning equipment can easily pass through the tube for cleaning of the full length of tubes.

3. All tubes are to be rolled in the holes drilled true and radially, to afford full
parallel bearing in the drum plate. Each tube hole shall be serrated to assure the tightest possible mechanical fit. Tubes shall be in proper alignment with the tube holes and shall be exact length for proper expanding and flaring.

4. All tubes in the furnace shall be finned except in the area where the gases leave the furnace and enter the convection zone. The inboard row of tubes between the furnace and the convection zone shall be finned forming a membrane wall to prevent short circuiting of flue gas from the furnace to the boiler flue gas outlet.

5. The thickness shall conform to the ASME Code for the pressure and conditions specified (shall be a minimum of 0.134” thick).

E. Casing and Insulation:

1. The boiler shall be completely encased in a double casing filled with blanket insulation. Inner casing shall be a minimum no. 10 gauge steel welded and shop air tested to minimize gas leakage and resultant boiler casing corrosion. External casing shall be a minimum no. 12 gauge and shall completely enclose the boiler with the exception of the four drum ends. The drum ends (heads) shall be field insulated by others. In addition to, and in areas not covered as stated above, the design shall provide refractory (i.e. brickwork) and/or insulation at the windbox, burner front plate, furnace front wall and rear wall, convection front wall and rear wall, furnace floor, steam drum shell, etc.

   The Vendor shall guarantee the design against overheating, warping or burning of the casing.

2. The entire boiler and furnace shall be supported by a rigid structural steel frame of heavy welded construction. The external casing covering the roof and side walls shall be of structural reinforced design and not require buckstays and shall be of a seal welded construction resulting in a gas tight envelope around the pressure vessel assembly.

3. The forced draft fan and silencer shall be front mounted and shall have its platform supported from the boiler framing or casing. The casing and/or framing of the boiler shall be strong enough to support a platform alongside the boiler steam drum.

4. Provide casing with valved and capped washout drain fittings.
5. At low points of enclosures, drain pockets shall be provided to collect liquids. The drain pockets will be provided with normally closed valves.

F. Refractory and Insulation:

All refractory and insulation shall be factory installed and shall be not less than first quality, as used in the best commercial practices, and shall conform substantially to the following:

1. The burner “front” wall exposed to the radiant heat and the entire target “rear” wall are to be provided with refractory and insulation of a total thickness specified by the Vendor based on a minimum service rating of 3000°F for the refractory and 1800°F for the insulation. The walls shall consist of at least 5” of high duty refractory tile, four-sided tongue and groove brick. The tile shall be backed up by insulating castable material of a suitable thickness to meet surface temperature requirements of this specification.

2. Side walls, roof and floor of the boiler and steam drum are to be completely covered with a minimum thickness of 3-1/2” of 1000°F insulating blanket of the fiberglass or mineral wool type.

3. The Vendor shall provide design details and thickness of refractory and insulation for the entire boiler in his design drawings submitted to the Engineer.

G. Access and Observation Ports:

1. Provide boiler with refractory or insulation-lined doors and openings for access to the furnace area and convection area (for access to the tube banks) having an Industry approved and registered latching device to hold the door tight against a non-asbestos gasket seal. Openings shall be 18” x 15” minimum other than the boiler register opening. The openings shall be complete with insulated cover plate or plates, gasketing, handles, bolts and nuts.

2. Three or more air cooled and heat resistant observation ports with Pyrex eye shields shall be provided and located at strategic points in the furnace target walls and burner register to afford full furnace vision. These ports shall be of a type to assure tight shutoff and permit lens change when the boiler is in operation.
H. Boiler Base:

1. The boiler base shall consist of welded steel beams and channels and design to support all frame work, casing, refractory, insulating materials, etc. The boiler weight shall be evenly distributed over the entire area of the base. The structural steel base shall be designed to permit the boiler to freely expand and contract without placing any undue stress on any part of the boiler or setting.

2. The lower drum shall be load bearing on the saddles in the boiler base. The water in the lower drum shall be completely drainable through either blowoff valve.

I. Ducts and Expansion Joints

1. The complete ducting system, including the expansion joints, from the inlet of the silencer for the forced draft fan to the economizer outlet, shall be properly designed for any internal pressure and/or vacuum that it may be subjected to under both normal and upset operating conditions.

2. The ducting system leading to the burner shall be designed with slow angle of divergence to reduce formation of eddies and turbulence. To improve the flow distribution, turning vanes or similar devices for correction of flow patterns may be employed.

3. Material of ductwork, guide vanes, expansion joints and all other components of the system should be as follows:
   Operating Temperature not Exceeding °F.
   Carbon Steel   800
   Corten Steel   900
   Stainless Steel 409 up to 1200
   Stainless Steel 304/316 1600

   The thickness of duct wall shall be 1/4" minimum, and shall be of welded construction, properly reinforced. Continuous welding at joints shall ensure gas tightness. Flanged joints shall be provided at all field connections and terminations with other vendors.

   All material and construction shall be suitable for thermal cycling and continuous operation at the design temperature. Stress levels will be maintained at limits to ensure a minimum creep life of 100,000 hours at the
design temperature.

4. All hot ducts shall be insulated and shall be provided with necessary ribs or attachments for proper fastening of wiring in place of insulation.

5. Suitable supports, anchors, expansion joints, access doors, adjustable spring hangers, flue gas sampling connections, gaskets, thermal insulation fasteners, etc. shall be furnished as required. Ductwork shall be reinforced with structures to as to eliminate any vibration or “oil-canning”, induced by flow dynamics.

6. Low points of ductwork shall be provided with drain pockets, suitably isolated with capped valve(s).

7. Expansion Joints
   a) Expansion joints shall be provided to absorb longitudinal expansion or contraction and shear movements due to temperature differential or misalignment and thus relieving stress out of major equipment. Expansion joints shall be of reinforced heat resistant fabrics with internal stainless steel liner or all-metallic, suitable for the working environment, and shall be of bellows design to maintain leak lightness. Sliding or sleeve type expansion joints are not acceptable.
   b) Welds on expansion joints shall be radiographed and dye penetrant tested, after forming and welding.
   c) The internal dimensions of the expansion joint shall match that of the main duct or boiler enclosure. The joints shall be covered with the internal plates to prevent eddies and turbulence. The expansion joints shall be lagged and clad separately from the main section of the duct.

8. Gaskets
   a) Meet or exceed requirements for service for conditions.

J. Vents, Drains and Blowdown

1. The boiler shall be provided with all necessary vents, drains and blowdown systems required for the safe operation and maintenance of the boiler system provided by the Vendor.
2. Air vents shall be incorporated in boiler steam and water circuits, and also on drum. All air vent lines will be complete with separate isolation valves.

4. All piping and fittings associated with the water and steam circuits of boiler shall be completely drainable.

4. Both continuous (CBD) and intermittent (IBD) blowdowns shall be provided. CBD will be done as surface blow from top steam drum and the circuit shall be sized for a maximum rate of 5% of boiler MCR. IBD will be done from bottom mud drum/headers to clear dirt, rust, etc. which may accumulate in the boiler circulation circuit.

K. Steel Works

1. The Vendor shall supply all necessary structural steelwork for encasement support, bracing of the boiler and its ancillary equipment.

2. The steelwork shall be provided in accordance with the general requirements for steelwork meeting all relevant AISC specifications.

3. Steelwork shall also be provided for piping supports and instrument mountings.

4. Structural steel shall be supplied in pre-fabricated form to minimize site erection work. The Vendor to keep in mind the space restrictions for layout and erection.

5. The design of the steel structures associated with the boiler shall meet the following requirements:

   a. The supporting structure shall be designed considering the internal forces and expansion.

   b. Consideration shall be made that the steel structure can also accept forces of the pipes and ducts which will be eventually supported by the building steel.

   c. In addition to this, the steel structure must be able to resist the forces resulting from water filling of the boiler and pipes during the hydraulic test, and from other loads during erection and operation.

   d. Special care shall be given to the design of pipe racks or supports, as
applicable, for steam and feedwater pipes, which must be able to also support these pipes during water filling hydraulic test and acid cleaning.

e. Ladders and platforms shall be supported so that no forces shall be introduced into the boiler body itself unless designed accordingly.

f. All nuts, bolts and washers must be galvanized or cadmium-coated, and properly protected against corrosion before installation.

L. Platforms and Ladders

1. A complete system of ladders and platforms and shall be provided as required for proper operation and maintenance. The design shall meet requirements of OSHA standards and the New York State Boiler Safety Code. All platforms and walkways shall have a minimum clear width of 3 feet and be designed for a minimum load of 100 pounds/sq. ft.

2. Access platforms shall be provided for all operating, inspection and observation stations, including valve stations, test connection points and site mounted instrumentation. For valves not readily accessible by platforms or ladders, chain wheel operator to floor shall be provided. As a minimum, platforms or ladders shall be provided to gain access to:

   a. All operating valves
   b. Instruments
   c. Observation doors/ports/manways
   d. Steam drum manholes, water gauge glass and columns
   e. Sampling points
   f. Safety relief valves
   g. Emissions control and monitoring equipment

3. Platform perimeters and major openings shall be protected with handrails, constructed with tubular fittings and pipes. A minimum of 7' - 0" headroom shall be maintained for all walkways and platforms. Continuous kickplates, projecting above the platform elevation shall be provided around all openings and platform edges.

4. Vertical ladders shall be provided with a safety cage as required by OSHA. Bottom of ladders shall be prepared for proper anchorage, either to platforms
or flooring.

5. Provision shall be made in the boiler casing and access platforms for the rapid and convenient installation of the inspection scaffolding furnished for maintenance and inspection.

6. All platforms and ladders shall be primed and finish painted with high temperature aluminum paint per this specification.

O. Pipe Sleeves and Instrument Connections:

1. Provide pipe sleeves in the walls of the boiler for combustion control, sampling and instrument connections.

2. Provide instrument connections in casing and flue outlet as required. All connections shall be properly sized, located and capped.

3. Provide ports and connections for all required emission control and monitoring equipment.

P. The Vendor shall furnish all miscellaneous steel, hangers, shoes, attachments, baseplates and related items for hanging or supporting of their equipment, piping and accessories.

2.04 TRIM CONNECTIONS AND ACCESSORIES

A. The boiler trim shall include a self-contained water column with all necessary alarms, cut-offs, gauges, isolation valves, drains, vents, instrument taps, etc. The water column and its level must be clearly visible from the floor level when operating the manual feedwater bypass valve and during column blowdown and shall including light, mirrors, etc. as necessary. In lieu of the water column trim normally provided for blowdown (such as trycocks and chains). The Vendor shall provide an optional cost for an electronic water level indicator, such as the Schlumberger Industries, HydraStep 2457.

B. The Vendor shall provide service connections necessary to safely operate and maintain the boiler system in accordance with industry standard, good engineering practice and all applicable codes. The Vendor shall identify the sizes and type of all connections in his approval drawings.
All flanged connections shall be rated in accordance with ANSI B16.5 for its service design conditions. All screwed connections shall be rated for its service design conditions.

All necessary continuous and intermittent blowdown, chemical feed, vent and drain connections shall be provided with isolation valves. Flow control of continuous blowdown shall be by others.

C. A minimum of two safety relief valves shall be provided and sized in accordance with the ASME code.

D. All main steam and feedwater components within the jurisdiction of ASME Code Section I, shall be code stamped. For the main steam section, the stop/check (non-return) valve shall be of angle type and the second stop valve shall be of straight-through type. Piping between these two valves shall be fitted with a visible and accessible drain valve.

E. A feedwater piping system shall be designed and supplied by the Vendor, complete with a feedwater level control valve (the Vendor shall offer a control valve by either Copes-Vulcan or Fisher Controls, with an option price for the other) and its three valve bypass and feedwater stop and check valves shall be provided in a pre-fabricated piped assembly. The piping design shall be stress analyzed and provided with hangers, supports, hardware, etc. by the Vendor to allow for field installation (if so required) by others.

F. The economizer trim shall be provided with means for isolation, including manual bypass, vent, drain and safety valves. If the economizer or its tubes are removable, the Vendor shall specify location and dimensions of space required for its removal.

G. The Vendor shall provide two (2) sets of taps on the steam drum for redundant water level measurement by others. Each tap shall be provided with an isolation valve and in addition, the upper tap shall be provided with a seal pot. Threaded connections are to be provided for the interface.

H. The Vendor shall provide a complete list, including number, size, manufacturer and model number of the steam, feedwater and economizer trim with his proposal. The boiler trim shall be factory-mounted with all integral connecting piping and drain lines terminating with a valve 3 feet above the operating floor level. If clearances do not permit shipment of all trim mounted on the unit, the subassemblies may be shipped loose for field-mounting.
I. The Vendor shall provide his recommendation for the use of soot blowers based on the
attached fuel analyses. However, even if soot blowers are not provided at this time,
both the convection area and the economizer shall be designed and constructed in the
empty lanes to accept passage of soot blowing media at a later date. In addition,
wall boxes and bearings shall be provided on enclosure walls at strategic locations, so
that if needed later, soot blowers can be retrofitted easily. All openings shall be
suitably blanked to permit operation without soot blowers at present.

2.05 EQUIPMENT LAYOUT

A. The Vendor shall prepare an equipment arrangement clearly identifying all boiler
equipment, including recommended maintenance space requirements (such as for oil
gun removal from the burner front).

2.06 LOW NOx FUEL BURNER

A. The Vendor shall provide as an integral part of the boiler system a dual fuel register
type low NOx package burner system suitable for forced draft operation. The burner
shall be designed for firing on either natural gas or no. 2 fuel oil with ignition on
natural gas only.

B. The burner assembly shall be prepackaged and mounted to the boiler prior to shipment
with all burner-front FM-approved piping and valve trains with atomizing steam system
and devices for instrumentation, controls, protection and safety interlocks, etc.,
including main and pilot gas and fuel oil headers, scanner cooling air header, spark-
ignited gas pilots, ignition transformer and flame scanners, etc. The burner system shall
be assembled, including prepiping and prewiring, and tested as a complete package
by the Vendor to assure component compatibility, capability, and proper function.

C. When firing either fuel, the burner must be capable of stable, operation and meet
guaranteed emission levels over the entire burner turndown range. If flue gas
recirculation is required, its rate shall not exceed 30% at any load. Steam or water
injection shall not be utilized to reduce emissions.

The burner shall be capable of burning liquid fuels by utilizing a single atomizer. Fuel
gas for the burner shall be utility grade natural gas at a minimum available regulated
gas pressure as required by the Vendor to meet turndown, etc. requirements. The
maximum expected gas pressure shall not exceed 40 psig. The Vendor shall provide a
pressure regulator and relief valve, as required, pre-piped on the Vendor’s pipe train.
D. The burner assembly shall be supplied complete with steam atomized oil unit, inside mix, complete with flexible metallic oil and steam hoses, burner couplings for easy removal of oil unit, and manual valves for each oil, steam and purge services.

E. The burner shall be furnished with a windbox plenum fabricated from 1/4” minimum steel plate complete with required structural framing, support legs, lifting lugs and bolted access door (18” square size). The burner manufacturer shall perform physical airflow distribution studies of the windbox and, the combustion air supply ductwork between the FD fan discharge and windbox inlet. Baffling shall be installed in the windbox as required to ensure proper peripheral distribution of combustion air at the burner inlet. The burner front plate and windbox shall be provided with factory-installed insulation by the Vendor and meet the surface temperature requirements provided in this specification.

F. Operating and Safety Controls: The unit shall be provided with a full complement of operating and safety controls, consisting of not less than the following items and features, which shall be shop assembled:

1. The package burner shall be designed in accordance with the applicable code requirements of NFPA 8501.

2. Automatic gas-electric ignition system.

3. Allen-Bradley PLC or Preferred Utilities burner programming and safety controller to automatically provide proper cycling for pre-combustion purge, ignition, start, stop, post-combustion purge and safety shutdown, for use on gas firing and oil firing. This controller shall be a standard product of the boiler or burner manufacturer. It shall use only UL and FM approved components.

4. Electronic type flame failure protection as part of the program controller to provide safety shutdown on failure of either the main flame or the pilot flame, with manual reset, flame failure and high temperature alarm, all on either oil or gas firing.

5. High pressure safety cutoff for steam.

6. Separate auxiliary low water safety cutoff for water level with momentary bypass push-button for blowdown function.

7. Air flow safety switch.
8. All piping trains, such as main and pilot gas, fuel oil, atomizing steam, etc. shall be mounted on the burner windbox. All electrical devices shall be prewired to terminals within a burner mounted junction box.

9. The gas trains shall be made from Schedule 40 pipe with standard butt-weld fittings and flanges for sizes 2-1/2" and above. The interconnection piping from the main gas train to the pilot gas train shall be provided and pre-piped by the Vendor.
   a. The pilot gas train shall conform to Factory Mutual and NFPA-8501 and be of the interruptible type consisting of two (2) pilot gas solenoid valves, one (1) pilot vent valve, one (1) manual shutoff valve, and a gas pressure regulator.
   b. The main gas train shall conform to Factory Mutual and NFPA-8501 and consist of two (2) main gas valves with one valve having an overtravel protection interlock, a flow control valve, a gas pressure regulator, one (1) vent valve, one (1) manual gas shutoff valve, high and low gas pressure limit protection, and main gas valve leak-test provisions.

10. The fuel oil train shall be constructed with Schedule 40 piping and shall conform to Factory Mutual and NFPA-8501 requirements consisting of one manual shutoff valve, one 3-way shutoff valve, one pressure gauge and test valve, fuel oil control valve, oil recirculating manual shutoff valve, and "Y" strainer. All electrical devices shall be prewired to terminate within a burner mounted box.

11. All controls for the boiler shall be enclosed in a suitable cabinet, with hinged door and lock, containing all necessary relays, PLC, contactors, terminal blocks, fuse blocks, fuses, transformers, switches, flame intensity meter, and colored indicating lights. All instruments on the panel front shall be identified by nameplate. An alarm horn and annunciator shall be provided on the panel to indicate fault condition. All wire terminations shall be numbered in accordance with the applicable wiring diagram. All wiring shall conform to the National Electric Code. This cabinet shall be located in the control room.

G. Flame Scanners and Flame Safety System

1. A minimum of one flame scanner and amplifier shall be provided for each burner element. The flame scanners shall be of ultraviolet (UV) type or infrared (IR) type, or a combination of the two. The scanner shall be Fireye brand.
2. Each flame scanner shall be located on an adjustable base to permit optimum sighting of flame.

3. The flame scanners shall be cooled and purged continuously to keep them clean of any particulate matter from combustion of fuel. If air is used as coolant, as well as purging agent, the same shall have to be arranged by the Vendor. The Vendor shall provide an option for scanners that do not require cooling.

4. The flame safety system shall be enclosed in a NEMA-12 enclosure and pre-mounted and prewired by the Vendor.

5. A flame safety system panel shall be enclosed in a NEMA-12 enclosure and shall be remotely located in the control room, and shall have all of the necessary indicator lights, pushbuttons, selector switches, flame intensity meters, etc. required to safely operate the burner from a remote location.

2.07 FORCED DRAFT FAN

A. Fan

1. The forced draft fan shall be furnished by the boiler manufacturer with a downblast discharge design. It shall be suitable, for remote mounting, from the boiler, at the floor level, and connected to the windbox through duct work. An inlet screen and silencer shall be provided at the air inlet of the fan.

2. The fan shall be of centrifugal, non-overloading type of proven design and directly driven by an induction motor in accordance with the electrical requirements of this specification and a steam turbine to prove operational flexibility. The steam turbine shall be provided in accordance with paragraph 2.08 of this specification. The fan speed shall not exceed 1,800 rpm. The fan shall be provided with accessories as required, including a clutch, flexible coupling, coupling guard, and vortex inlet vane damper. The inlet vane damper shall be controlled by the combustion control system. All linkages required by the Vendor and not shop installed shall be match marked for ease of correct installation in the field by others. The Vendor shall provide complete installation instructions, detailed drawings, mounting brackets for damper actuators, and as required.
3. The theoretical static pressure of the fan at MCR condition shall account for losses in all duct work, entrance loss, windbox, burner, furnace, heat transfer zones, dampers, etc., including 2" WG positive pressure at the economizer outlet. To arrive at test block conditions, the following margins shall be considered:

   Capacity: 10% over calculated volume, including excess air
   Static pressure: 21% over theoretical value

Design inlet air temperature shall consider combined temperature of (FGR) flue gas recirculation with an indoor ambient maximum temperature of 100°F.

4. FGR system to meet the emissions thresholds, without a separate flue gas recirculation fan. The purpose of the inlet box is to thoroughly mix the combustion air with flue gas recirculation (if required). The inlet box shall be provided with flange connections for connecting to both the air intake and FGR ducts.

5. Means shall be provided for the air flow measurement at F.D. fan outlet. The Vendor shall furnish an air flow versus dp (pressure drop) curve of the flow element offered.

6. The fan shall be constructed of the following materials:

   Shaft:
   Forged heat-treated steel

   Rotor:
   Mild steel center and shroud plates

   Housing:
   Mild steel not less than 3/16" thick

   Fan Blades:
   Manufacturer’s standard to match service conditions.

7. The bearings shall be self-aligning radial type, ring piled with horizontally split housing, air cooled and arranged to permit disassembly without rotor removal. The bearing shall have a service life of 25,000 hours.

8. The inlet silencer of the fan shall attenuate the fan noise by at least 10 dba and as required to meet the noise requirements specified herein and as part of the entire boiler system.
2.08 GENERAL-PURPOSE STEAM TURBINE (For the Forced-Draft Fans)

A. Purpose

1. This section covers the minimum requirements for general-purpose steam turbines. These requirements include basic design, materials, related lubrication systems, controls, auxiliary equipment and accessories.

2. Steam turbines are classified general-purpose or special-purpose according to service requirements as described as follows:

   a. General-purpose turbines are horizontal turbines used to drive equipment where steam conditions will not exceed a pressure of 13.8 bar (200 pounds per square inch gauge) and a temperature of 212°C (413°F) or where speed will not exceed 6000 revolutions per minute.

3. Provide one (1) back-pressure steam turbine per forced-draft fan. The provision for the new steam turbine will be complete with, but not limited to, the following:

   a. Steam chest
   b. Casing
   c. Rotor with stainless steel blading
   d. Babbitted sleeve bearings
   e. Coupling
   f. Governor, Woodward Peak 150, NEMA “D”
   g. Tachometer
   h. Seals
   i. Hand Valves (2 per turbine)
   j. Insulation
   k. Vacuum Breaker
   l. Gauge Board, complete with gauges
   m. Lubrication system, complete with auxiliary oil pump and motor starter
   n. Vibration detection system, complete with detectors
   o. Baseplate (skid)
   p. Steam expansion joint(s), complete with gaskets
   q. Tools as required
   r. Lubricants as required
   s. Acoustical treatment for the turbine
   t. Touch-up paint
B. Conflicting Requirements

1. In case of conflict between this section and the inquiry or order, the information included in the order shall govern.

C. References

1. The purchaser and the vendor shall mutually determine the measures that must be taken to comply with any governmental codes, regulations, ordinances, or rules that are applicable to the equipment.
2. It is the vendor’s responsibility to invoke all applicable specifications to each sub-vendor the data sheets.

D. Basic Design

1. The equipment (including auxiliaries) covered by this specification shall be designed, manufactured and assembled in the United States for a minimum service life of 20 years and at least 3 years of uninterrupted operation (except for normal preventative maintenance).

2. The turbine’s operating point shall meet performance with a steam flow not to exceed specified steam rate in lbs./hr. as outlined on the schedule.

3. Turbines shall be capable of the following:
   
a. Operating at normal power and speed under normal steam conditions. The manufacturer’s certified steam rate shall be at these conditions.

b. Delivering rated power at its corresponding speed with coincident minimum inlet and maximum exhaust conditions as required by the forced draft fan. To prevent oversizing or to obtain higher operating efficiency, the purchaser may desire to limit maximum turbine capability by specifying normal or a selected percentage of rated power instead of rated power.

c. Continuously operating at maximum continuous speed and at any speed within the range specified.
d. Continuously operating at rated power and speed under maximum inlet steam conditions and maximum or minimum exhaust steam conditions.

e. Operating with variations from rated steam conditions in accordance with NEMA SM23.

4. Equipment shall be designed to run to the trip speed and relief valve settings without damage.

5. The turbine wheel shall be located between the bearings. Other arrangements require specific approval from the Engineer.

6. Oil reservoirs and housings that enclose moving lubricated parts (such as bearings, shaft seals, highly polished parts, instruments, and control elements) shall be designed to minimize contamination by moisture, dust, and other foreign matter during periods of operation and idleness.

7. A cooling water system or systems shall be designed for the following conditions:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity over heat exchanger surfaces</td>
<td>1.5-2.5 mls</td>
</tr>
<tr>
<td></td>
<td>5-8 ft/s</td>
</tr>
<tr>
<td>Maximum allowable working pressure</td>
<td>6.9 bar</td>
</tr>
<tr>
<td></td>
<td>100 psig</td>
</tr>
<tr>
<td>Test pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.4 bar</td>
</tr>
<tr>
<td></td>
<td>150 psig</td>
</tr>
<tr>
<td>Maximum pressure drop</td>
<td>1 bar</td>
</tr>
<tr>
<td></td>
<td>15psi</td>
</tr>
<tr>
<td>Maximum inlet temperature (see note)</td>
<td>30°C</td>
</tr>
<tr>
<td></td>
<td>90°F</td>
</tr>
<tr>
<td>Maximum outlet temperature</td>
<td>50°C</td>
</tr>
<tr>
<td></td>
<td>120°F</td>
</tr>
<tr>
<td>Fouling factor on water side</td>
<td>0.35 m²K/kW</td>
</tr>
<tr>
<td></td>
<td>0.002 hr·ft²·F/Btu</td>
</tr>
</tbody>
</table>
Provision shall be made for complete venting and draining of the system.

Note: The vendor shall notify the purchaser if the criteria for minimum temperature rise and velocity over heat exchanger surfaces result in a conflict. The criterion for velocity over heat exchange surfaces is intended to minimize waterside fouling; the criterion for minimum temperature rise is intended to minimize the use of cooling water.

8. To avoid condensation, the minimum inlet water temperature to the bearing housings should preferably be above the ambient air temperature.

9. Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort of the purchaser and the vendor. The equipment furnished by the vendor shall conform to the maximum allowable sound pressure level specified by the purchaser.

10. Spare parts for the machine and all furnished auxiliaries shall meet all the criteria of this section.

E. Pressure Casings

1. All pressure parts shall be A-278 CL40 cast iron or cast steel A-216 Gr WCB at least suitable for operation at the most severe coincident conditions of pressure and temperature expected for the specified steam conditions.

2. The hoop-stress values used in the design of the casing shall not exceed the maximum allowable stress values in tension specified in Section VIII, Division I, of the ASME Code at the maximum operating temperature of the material used.

3. Axially split casings shall use a metal-to-metal joint (with a suitable joint compound) that is tightly maintained by suitable bolting. Gaskets (including string type) shall not be used on the axial joint.

4. Axially split horizontal turbines shall be designed to permit inspection and removal of the rotor and wearing parts without removing the casing from its foundation or disconnecting inlet or exhaust steam piping (except when up exhaust is specified), and will be centerline support type.

5. Casings and supports shall be designed to have sufficient strength and rigidity to limit any change of shaft alignment at the coupling flange (caused by the worst combination of allowable pressure, torque, and piping forces.
and moments) to 50 micrometers (0.002 inches). Supports and alignment bolts shall be rigid enough to permit the machine to be moved by the use of lateral and axial jackscrews, axially split horizontal turbines shall have centerline supports to maintain proper alignment with connected equipment. The lower horizontal mounting surface of each turbine support shall be machined parallel within 0.17 millimeter per meter (0.002 inch per foot) (1:6000). Corresponding surfaces shall be coplanar within 0.17 millimeter per meter of distance between surfaces (0.002 inch per foot),

6. Drain connections shall be provided for the steam chest, casing, packing glands, and cooling jackets.

7. On condensing turbines, when required by the orientation of the exhaust nozzle or piping, or when specified by the purchaser, the vendor shall provide an automatic draining system with the turbine.

8. Gauge connections shall be provided for the steam-ring chamber on single-valve turbines.


10. Studs are preferred to cap screws.

11. Studded connections shall be furnished with studs and nuts installed. Blind stud holes should be drilled only deep enough to allow a preferred tap depth of 1 1/2 times the major diameter of the stud; the first 1 1/2 threads at both ends of each stud shall be removed.

12. Slotted-nut or spanner-type bolting shall not be used unless specifically approved by the purchaser.

13. Adequate clearance shall be provided at bolting locations to permit the use of socket or box wrenches.

14. The machined finish of the mounting surface shall be 3 to 6 micrometers (125 to 250 micro inches) arithmetic average roughness ($R_a$). Hold-down or foundation bolt holes shall be drilled perpendicular to the mounting surface or surfaces and spot faced to a diameter three times that of the hole.

15. Equipment feet shall be drilled with pilot holes for use in final doweling.
F. Casing Appurtenances

All nozzles or nozzle blocks shall be replaceable. All other stationary blading shall be mounted in replaceable diaphragms or segments.

G. Casing Connections

1. Inlet and outlet connections shall be flanged or machined and studded, oriented as specified on the data sheets, and suitable for the maximum inlet and maximum exhaust conditions as specified. Steam inlet shall be on the right hand side and the exhaust will be on the left hand side when viewed from the governor end.

2. Casing openings for piping connections shall be at least NPS ¾ and shall be flanged or machined and studded. Where flanged or machined and studded openings are impractical, threaded openings in sizes NPS ¾ through 1½ are permissible. These threaded openings shall be installed as specified.
   a. A pipe nipple, preferably not more than 150 millimeters (6 inches) long, shall be screwed into the threaded opening.
   b. Pipe nipples shall be provided with welding-neck or socket-weld flanges for steam pressures of 12 bar (175 psig) or higher.

3. Flanges shall conform to ASME B16.1 or B16.5, or B16.42 as applicable, except as follows:
   a. Cast iron flanges shall be flat faced and shall have a minimum thickness of Class 250 in accordance with ASME B16.1 for sizes 8 inches and smaller.
   b. Flat-faced flanges are acceptable on all exhaust connections. Flat-faced flanges shall have full raised-face thickness.
   c. Flanges that are thicker or have a larger outside diameter than that required by ASME B 16.1, B16.5, or B 16.42, as applicable, are acceptable.
   d. All of the purchaser's connections shall be accessible for disassembly without moving the machine.
H. External Forces and Moments

Turbines shall be designed to withstand the external forces and moments calculated in accordance with NEMA SM 23.

I. Rotating Elements

1. Rotors
   a. Rotors shall be capable of operating without damage at momentary speeds up to 110 percent of trip.
   b. Rotors (other than integrally forged shafts and disks) shall be assembled to prevent movement of the disk relative to the shaft when operating at any specified start-up or operating condition and any speed up to 110 percent of trip speed. The wheels shall be keyed to the shaft and assembled with a shrink fit.
   c. The purchaser’s specific approval is required for built-up rotors when blade tip velocities at maximum continuous speed exceed 250 meters per second (825 feet per second) or when stage inlet steam temperatures exceed 440°C (825°F).

2. Shafts
   a. Shafts shall be accurately furnished throughout their entire length and shall be ground to a finish of 0.8 micrometer (32 micro inches) R. or better at the coupling and bearing locations and sealing areas for carbon ring packing.
      1) For areas to be observed by radial vibration probes, 5 micrometers (0.25 mil). Add shaft burnishing automatically whenever provisions for vibration probes are specified.
      2) For areas to be observed by axial-position probes, 10 micrometers (0.5 mil).
   b. Shafts shall be protected by corrosion-resistant material under carbon ring packing for casing end glands. The manufacturer’s application
method, the coating material used, and the finished coating thickness shall be stated on the data sheets.

c. Keyways shall have fillet radii conforming to ASME B17.1.

3. **Blading**

a. Combined stress levels (steady state plus cyclic) developed in rotating blades at any equipment operating condition shall be low enough to ensure trouble-free operation even if resonant vibration occurs.

b. All blades shall be mechanically suitable for operation (including transient conditions) over the specified speed range and momentarily up to 110 percent of trip speed.

J. **Seals**

1. Outer glands shall be sealed at the shaft by carbon-ring or replaceable labyrinth packing, a combination of both or by non-contacting end face mechanical seals.

2. Carbon-ring packing shall be used only when the rubbing speed at the shaft sealing surface is less than 50 meters per second (160 feet per second). The number of carbon rings shall be determined by the service and venting requirements, with 2.4 bar (35 pounds per square inch) being the maximum allowable average differential pressure per active sealing ring. Springs for carbon packing shall be made of nickel chromium-iron alloy (heat treated after cold coiling) or equal material. Variations in operating steam temperature shall be considered when the required cold clearances for packing rings are established.

3. Gland cases shall be furnished with a full complement of carbon rings.

4. Glands that operate at less than atmospheric pressure shall be designed to admit steam that will seal against air leakage. Piping with relief valves, pressure gauges, regulators and other necessary valves shall be provided to interconnect the end glands. Piping shall have one common connection to the purchaser's sealing-steam supply. When specified, the admission of sealing steam shall be automatically controlled throughout the load range. The normal operating sealing-steam supply shall preferably come from a positive-pressure section of the turbine.
5. The gland casing leakoff connections shall comply with Section 2.08, G, 2.

K. Dynamics
   1. Critical Speeds
      
a. When the frequency of a periodic forcing phenomenon (exciting frequency) applied to a rotor-bearing support system corresponds to a natural frequency of that system, the system may be in a state of resonance.

b. A rotor-bearing support system in resonance will have its normal vibration displacement amplified. The magnitude of amplification and the rate of phase-angle change are related to the amount of damping in the system and to the mode shape taken by the rotor.

c. An exciting frequency may be less than, equal to, or greater than the rotational speed of the rotor. Potential exciting frequencies that are considered in system design shall include but are not limited to the following sources:

1) Unbalance in the rotor system.
2) Oil-film instabilities (whirl)
3) Internal rubs.
4) Blade, vane, nozzle, and diffuser passing frequencies.
5) Gear-tooth meshing and side bands.
6) Coupling misalignment.
7) Loose rotor-system components,
8) Hysteretic and friction whirl.
9) Boundary-layer flow separation.
10) Acoustic and aerodynamic cross-coupling forces.
11) Asynchronous whirl.
12) Ball and race frequencies of antifriction bearings.

d. Resonances of structural support systems may adversely affect the rotor vibration amplitude. Therefore, resonances of structural support systems that are within the vendor's scope of supply and that affect the rotor vibration amplitude shall not occur within the specified operating
speed range or the specified separation margins, unless the resonances are critically damped.

e. The first rigid mode of single-stage turbines shall be at least 120 percent of maximum continuous speed.

2. Lateral Analysis

a. The vendor’s standard critical speed values that have previously been analytically derived and test proven for prior manufactured turbines of the same frame size and rotor/bearing configuration are acceptable. Manufacturer shall provide engineering data and shall submit to the purchaser as part of the proposal.

3. Torsional Analysis

a. Excitations of undampened torsional natural frequencies may come from many sources which should be considered in the analysis. These sources may include but are not limited to the following:

1) Start-up conditions such as speed detents and other torsional oscillations.
2) Oscillations.
3) Hydraulic-governor control-loop resonances.
4) Running speed or speeds,
5) Manufacturer shall provide engineering data for the analysis.

4. Vibration and Balancing

a. Each disk or thrust collar shall be given a single-plane balance before it is assembled on its own shaft. Other major parts shall be given an individual dynamic balance before they are assembled on the shaft, (not if turbine is less than 300 hp).

b. High-speed balancing (balancing in a high-speed balancing machine at the operating speed) shall be done only with the purchaser’s specific approval. The acceptance criteria for this balancing shall be mutually agreed upon by the purchaser and the vendor.
c. If the vendor can demonstrate that electrical or mechanical runout is present, a maximum of 25 percent of the test level calculated from Equation 2 or 6 micrometers (0.25 mil), whichever is greater, may be vectorially subtracted from the vibration signal measured during the factory test.

d. Each component will not be individually balanced. The rotor will be balanced with all of these parts.

L. Bearings and Bearing Housings

1. Hydrodynamic radial bearings shall be required under the followings conditions:

a. Where antifriction-bearing $dN$ factors are 300,000 or more. A $dN$ factor is the product of bearing size (bore) in millimeters and rated speed in revolutions per minute.

2. Horizontal turbines shall be equipped with thrust bearings designed to handle axial loads in either direction. Turbines shall have hydrodynamic thrust bearings when specified or where antifriction bearings fail to meet the minimum L10 rating life.

3. Antifriction bearings shall be retained on the shaft and fitted into housings in accordance with the requirements of ABMA Standard 7; however, the device used, lock ball thrust bearings to the shaft shall be restricted to a nut with a tongue-type lock-washer, such as Series W, or a snap ring.

4. Except for the angular contact type, antifriction bearings shall have a loose internal clearance fit equivalent to ABMA Symbol 3, as defined in ABMA Standard 20. Single- or double-row bearings shall be of the Conrad type (no filling slots).

5. Hydrodynamic radial bearings shall be split for ease of assembly, precision bored, and of the sleeve or pad type, with steel-backed, babbitted replaceable liners, pads, or shells. These bearings shall be equipped with anti-rotation pins and shall be positively secured in the axial direction.

6. The bearing design shall suppress hydrodynamic instabilities and provide sufficient damping over the entire range of allowable bearing clearances to limit rotor vibration to the maximum specified amplitudes while the equipment is
operating loaded or unloaded at specified operating speeds, including operation at any critical frequency.

7. The liners, pads, or shells shall be in horizontally split housings and shall be replaceable without removing the top half of the casing of an axially split machine or the head of a radially split unit and without removing the coupling hub.

8. Bearings shall be designed to prevent their installation backwards and/or upside down.

9. Hydrodynamic thrust bearings shall be in accordance with the following:

a. Hydrodynamic thrust bearings shall be of the steel-backed, babbitted multiple-segment type, designed for equal thrust capacity in both directions and arranged for continuous pressurized lubrication to each side. Both sides shall be of the tilting-pad type, incorporating a self-leveling feature that assures that each pad carries an equal share of the thrust load with minor variation in pad thickness. Each pad shall be designed and manufactured with dimensional precision (thickness variation) that will allow interchange or replacement of individual pads.

b. Integral thrust collars are preferred for hydrodynamic thrust bearings. When integral collars are furnished, they shall be provided with at least 3 millimeters (1/8 inch) of additional stock to enable refinishing if the collar is damaged. When replaceable collars are furnished (for assembly and maintenance purposes), they shall be positively locked to the shaft to prevent fretting.

c. Both faces of thrust collars for hydrodynamic thrust bearings shall have a surface finish of not more than 0.4 micrometers (16 micro inches) $R_a$ and the axial total indicated rimout of either face shall not exceed 12 micrometers (0.0005 inch).

10. Thrust bearings shall be sized for continuous operation under the most adverse specified operating conditions.

11. Thrust forces for flexible-element couplings shall be calculated on the basis of the maximum allowable deflection permitted by the coupling manufacturer.
12. If two or more rotor thrust forces are to be carried by one thrust bearing (such as in a gear box), the resultant of the forces shall be used if the directions of the forces make them numerically additive; otherwise, the largest of the forces shall be used.

13. Hydrodynamic thrust bearings shall be selected at no more than 50 percent of the bearing manufacturer's ultimate load rating. The ultimate load rating is the load that will produce the minimum acceptable oil-film thickness without inducing failure during continuous service or the load that will not exceed the creep initiation or yield strength of the Babbitt at the location of maximum temperature on the pad, whichever load is less.

14. Thrust bearings shall allow axial positioning of each rotor relative to the casing and setting of the thrust bearings' clearance or preload.

15. Axially split bearing housings shall have a metal-to-metal split joint whose halves are located by means of cylindrical dowels.

16. Bearing housings for pressure-lubricated hydrodynamic bearings shall be arranged to minimize foaming. The drain system shall be adequate to maintain the oil and foam level below shaft end seals. The rise in oil temperature through the bearing and housings shall not exceed 30°C (50°F) under the most adverse specified operating conditions. The bearing-oil outlet temperature shall not exceed 80°C (180°F). When the inlet oil temperature exceeds 50°C (120°F), special consideration shall be given to bearing design, oil flow, and allowable temperature rise. Oil outlets from flooded thrust bearings shall be tangential and in the upper half of the control ring or, if control rings are not used, in the thrust-bearing cartridge.

17. Oil inlet and drain connections shall be flanged or machined and studded. Threaded openings are permissible in NPS ¾, 1, and 1½. Pipe connections in NPS 1½ inch tapped openings shall be installed as follows:

a. The threaded connection shall be seal welded; however, seal welding is not required on cast iron bearing housings or where disassembly is required for maintenance. Seal-welded joints shall be in accordance with ASME B31.3. Threaded connections that are not seal welded shall be made up without thread tape.
b. Pipe or tube fittings on NPS 3/4 and 1 connections shall not be seal welded.

18. Tapped openings that may later be connected to customer piping shall be plugged with solid roundhead steel plugs furnished in accordance with ANSI B16.11. Thread tape shall not be used.

19. Bearing housings shall be equipped with replaceable end seals that effectively prevent the ingress of steam, condensation and foreign material through the area where the shaft passes through the housing. The seals shall be designed to effectively retain oil in the bearing housing. The seals shall be metallic, non-sparking, noncontact and non-wearing. Radial axial pattern seals and magnetic seals are acceptable. Lip-type seals shall not be used.

20. Bearing housings shall provide adequate protection against contamination by steam condensate, particularly during periods of idleness.

21. Bearing housings for oil-lubricated non-pressure-fed bearings shall be provided with tapped and plugged fill and drain openings at least NPS 1/2 in size, or may be filled through the oiler. The housing shall be equipped with constant-level sightfeed oilers at least 0.1 liter (4 ounces) in size, with a positive level positioner (not a set screw), heat-resistant glass containers, (not subject to sunlight- or heat-induced opacity or deterioration), and protective wire cages. A permanent indication of the proper oil level shall be accurately located and clearly marked on the outside of the bearing housing with permanent metal tags, marks inscribed in the castings, or another durable means.

22. Housing for ring-oil lubricated bearings shall be provided with plugged ports positioned to allow visual inspection of the oil rings while the turbine is running.

23. An NPS 1/4 oil mist inlet connection, shall be provided in the top half of the bearing housing. The pure or purge oil mist fitting connections shall be located so that oil mist will flow through antifriction bearings. There shall be no internal passages to short-circuit oil mist from inlet to vent. If bearings are of the sleeve type, the connections for the condensing oil mist fittings shall be located over the bearings so the makeup oil will drip into the bearings.

24. An NPS 1/4 vent connection, shall be provided on the housing or end cover for each of the spaces between antifriction bearings and the housing shaft.
closures. Housings with only sleeve-type bearings shall have the vent located near the end of the housing.

25. Shielded or sealed bearings shall not be used.

26. Sufficient cooling capacity, including and allowance for fouling, shall be provided to maintain the oil temperature below 70°C (160°F) for pressurized systems and below 80°C (180°F) for ring-oiled or splash systems, based on the specified operation conditions and an ambient temperature of 40°C (110°F). Where cooling is required water jackets shall have only external connections between the upper and lower housing jackets and shall have neither gasketed nor threaded connection joints, which may allow water to leak into the oil reservoir. If cooling coils (including fittings) are used, they shall be of nonferrous material and shall have no pressure joints or fittings internal to the bearing housing. Coils shall have a minimum thickness of at least 19 Birmingham wire gauge (BWG) 1 millimeter (0.042 inch) and shall be at least 12 millimeters (0.50 inch) in diameter.

M. Lubrication

1. Unless otherwise specified, bearings and bearing housings for horizontal units shall be arranged for hydrocarbon oil lubrication by Trico.

2. An austenitic stainless steel oil reservoir shall be supplied with the following characteristics and appendages:

   a. The capacity to avoid frequent refilling and to provide adequate allowance for system rundown, and to provide a retention time of at least 3 minutes to settle moisture and foreign matter adequately,

   b. Provisions to eliminate air and minimize flotation of foreign matter to pump suction.

   c. Fill connection, armored gauge glass with level indication, and a breather suitable for outdoor use.

   d. Sloped bottom and connection for complete drainage.

   e. Clean out opening as large as practicable.
3. A main oil pump driven by the shaft, unless another source of pressurized oil is provided. Oil draining from the suction line during periods of idleness shall not cause damage to the pump during unattended start-up.

4. An oil cooler, preferably separate and of the shell-and-tube type. Oil coolers internal to the reservoir are not acceptable.

5. A full-flow filter with replaceable elements and filtration of 25 microns nominal or finer. Filter cartridge material shall be corrosion resistant. Metal-mesh or sintered metal filter elements are not acceptable. Filters shall not be equipped with a relief valve or an automatic bypass.

6. A temperature gauge after the oil cooler.

7. Pressure gauges (valved for removal) to measure pressure before and after the filter.

8. Low-oil-pressure shutdown device or switch.

9. Main and standby oil pumps shall have steel cases unless they are enclosed in a reservoir; however, casings of shaft-driven oil pumps may be made of iron. All other oil-containing pressure components shall be made of steel.

N. Materials

1. General

   a. Materials of construction shall be the manufacturer’s standard for the specified operating conditions.

For the Class 1 Turbine:

1) Casing and Steam Chest Cast Iron A-278 CL40
2) Rotor, Disc Ductile Iron ASTM A395M
3) Rotor, Shaft Steel AISI C4144
4) Rotor, Blades Stainless Steel AISI 403
5) Packing Cases Cast Iron A-278 CL40
6) Nozzle Ring Stainless Steel AISI 416
7) Bearing Cases Cast Iron A-278 CL40
8) Governor Valve/Seat ASTM A743 CA-40 Stainless Steel
9) Governor Valve Stem  
ASTM A743 CA-40 Stainless Steel

10) Steam Strainer  
Stainless Steel AISI 316, 0.062" Mesh

11) Trip Valve  
Stainless Steel AISI 416

12) Trip Valve Seat  
Same as Trip Valve

13) Casing Bolting  
Carbon Steel GR 8

14) Bearings Wheel  
Carbon Stl Ball #6307 (20", 23"

15) Bearings  
Liner Type Slv Brg (24" Wheel)

b. Materials shall be identified in the proposal with their applicable ASTM, AISI, ASME, or SAE numbers, including the material grade. When no such designation is available, the vendor’s material specification, giving physical properties, chemical composition, and test requirements, shall be included in the proposal.

c. Pressure parts shall be made of steel if the maximum steam conditions to which they may be subjected exceed 17 bar (250 pounds per square inch gauge) or 260°C (500°F). Exhaust casings of noncondensing turbines shall be made of steel if the maximum exhaust pressure may exceed 5.2 bar (75 pounds per square inch), or if the no-load exhaust temperature may exceed 260°C (500°F). Suitable alloy steel shall be used where the maximum steam temperatures may exceed 413°C (775°F). Ductile iron may be used only with the approval of the purchaser.

d. Materials for other turbine parts shall be the manufacturer’s standard for the shaft and wheels, 11-13 Cr for blading and nozzles (rotating and stationary), 11-13 Cr or nickel-copper for the shrouding, and 18-8 stainless steel for the steam strainer.

e. Note - Torque loading values will differ considerably with and without anti-seizure compound.

f. For the pressure casing, materials, casting factors, and the quality of any welding shall be equal to those required by Section VIII, Division I, of the ASME Code. The manufacturer’s data report forms, as specified in the code, are not required.

2. Castings
a. Castings shall be sound and free from porosity, hot tears, shrink holes, blow holes, cracks, scale, blisters, and similar injurious defects. Surfaces of castings shall be cleaned by sandblasting, shotblasting, chemical cleaning, or any other standard method. Mold-parting fins and remains of gates and risers shall be chipped, filed, or ground flush.

b. The use of chaplets in pressure castings shall be held to a minimum. The chaplets shall be clean and corrosion free (plating permitted) and of a composition that is compatible with the casting.

c. Ferrous castings shall not be repaired by welding, peening, plugging, burning in, or impregnating.

3. Welding

a. Welding of piping and pressure-containing parts, as well as any dissimilar metal welds and weld repairs, shall be performed and inspected by operators and procedures qualified in accordance with Section VIII, Division I, and Section IX of the ASME Code.

b. All welds shall be heat treated in accordance with Section VIII, Division I, Sections UW-10 and UW-40, of the ASME Code.

O. Nameplates and Rotation Arrows

1. A nameplate shall be securely attached at a readily visible location on the equipment and on any other major piece of auxiliary equipment.

2. Rotation arrows shall be cast in or attached to each major item of rotating equipment at a readily visible location. Nameplates and rotation arrows (if attached) shall be of AISI Standard Type 300 stainless steel or of nickel-copper alloy (Monel or its equivalent). Attachment pins shall be of the same material. Welding is not permitted.

P. Accessories

1. Couplings and Guards

a. Unless otherwise specified, flexible element couplings and guards between turbines and driven equipment shall be supplied by the
manufacturer of the driven equipment. If specified, the driver half of the coupling shall be mounted by the turbine manufacturer.

b. The power rating of the coupling-to-shaft juncture shall be at least equal to the driver’s rated power times the coupling service factor for the application per AGMA 9002. The make, type, and mounting arrangement of the couplings shall be agreed upon by the purchaser and the vendors of the driver and driven equipment. A spacer coupling with a minimum 125-millimeter (5-inch) spacer shall be used, unless otherwise specified. Couplings shall be forged steel and designed to allow the necessary end float caused by expansion and other end movements of the shaft.

c. For all turbines, the coupling surfaces normally used for checking alignment shall be concentric to the axis of coupling hub rotation within the following limits: 13 micrometers (0.0005 inch) TIR per inch of shaft diameter, with a minimum applicable tolerance of 25 micrometers (0.001 inch) TIR and a maximum of 75 micrometers (0.003 inch) TIR. All other diameters that are not used for locating, registration, or alignment shall conform to the coupling manufacturer’s standard, provided that dynamic balance requirements are met.

d. For turbines connected to their driven equipment with a flexible coupling, the locating and alignment faces shall be perpendicular to the axis within the limits of Section 2.08, P.1.c.

e. An easily removable coupling guard shall be placed over all exposed couplings furnished by the vendor. The coupling guard shall be of sufficiently rigid design to withstand deflection and consequent rubbing as a result of bodily contact and shall extend to within 13 millimeters (0.5 inch) of the stationary housing.

2. Controls and Instrumentation

a. General

1) Instrumentation and its installation shall conform to detailed specifications in the purchaser’s inquiry or order or both.
2) Hand-operated nozzle control valves shall be supplied for economical operation at other than normal operating conditions. The vendor shall state the required number of hand valves and shall provide performance data.

b. Control Systems

1) Turbines shall be equipped with a corrosion-resistant steam strainer located ahead of the governor and trip valves. The minimum effective free area of the strainer shall be twice the cross-sectional area of the turbine inlet connection. The strainer shall be removable.

2) Unless otherwise specified, a NEMA Class A oil-relay governor shall be supplied. The governor shall conform to NEMA SM 23 as manufactured by Woodward TG-13 or TG-17 with 20% range change.

3) Unless otherwise specified, speed shall be adjusted by means of a hand speed changer.

c. The full range of the purchaser's specified control signal shall correspond to the required operating range of the driven equipment. Unless otherwise specified, the maximum control signal shall correspond to the maximum continuous speed.

d. Actuation or failure of the control signal or failure of the speed setting mechanism shall not prevent the governor from limiting speed to the maximum permissible, nor shall either occurrence prevent manual regulation with the hand speed changer.

e. Unless otherwise specified, the adjustable speed range of the governor and hand speed changer shall be a total of 20 percent of the maximum continuous speed: 5 percent greater and 15 percent less than normal speed.

f. The speed-governing valve shall be the manufacturer's standard, preferably a balanced type.
g. Trip and speed-governing valves shall have a metallic or compressible type of bushing-valve stem packing and an intermediate leakoff when the maximum inlet steam pressure is 17 bar (250 psig) or higher.

h. The turbine shall be equipped with an independent emergency overspeed system that shuts off steam to the turbine when running speed reaches trip speed. The emergency trip system shall have the following characteristics:

1) Easy accessibility.
2) The capability to be manually tripped with maximum inlet steam pressure and flow in the line.
3) The capability to stop the turbine by activating a force-actuated trip valve under any load condition of the turbine.
4) The capability to be reset with maximum inlet pressure on the line.

Note - The purchaser should provide a block valve on the inlet steam line close to the turbine. This valve should be closed before the overspeed trip system is reset.

3. Piping and Appurtenances

a. In accordance with ASME B31.3. Unless otherwise specified, radiographic examination is not required.

b. Auxiliary systems are defined as piping systems that are in the following services:

1) Steam, including sealing steam.
2) Instrument and control air.
3) Lubricating oil.
4) Control oil.
5) Cooling water.
6) Drains and vents.

c. Piping systems shall include piping, isolating valves, control valves, relief valves, pressure reducers, orifices, temperature gauges and thermowells, pressure gauges, sight flow indicators, and all related vents and drains as provided by the Contractor.
d. Where space does not permit the use of NPS 1½, ¾, or 1-inch pipe, seamless tubing may be furnished.

e. Oil Piping

1) Oil drains shall be sized to run no more than half full when flowing at a velocity of 0.3 meter per second (1 foot per second) and shall be arranged to ensure good drainage (recognizing the possibility of foaming conditions). Horizontal runs shall slope continuously, at least 40 millimeters per meter (½ inch per foot), toward the reservoir. If possible, laterals (not more than one in any transverse plane) should enter drain headers at 45-degree angles in the direction of the flow.

2) Non-consumable backup rings and sleeve-type joints shall not be used. Pressure piping downstream of oil filters shall be free from internal obstructions that could accumulate dirt. Socket-welded fittings shall not be used in pressure piping downstream of oil filters.

4. Special Tools

a. When special tools and fixtures are required to disassemble, assemble, or maintain the unit, they shall be included in the quotation and furnished as part of the initial supply of the machine. For multiple-unit installations, the requirements for quantities of special tools and fixtures shall be mutually agreed upon by the purchaser and the vendor. These or similar special tools shall be used during shop assembly and post-test disassembly of the equipment.

b. When special tools are provided, they shall be packaged in separate, rugged boxes and marked special tools for (tag/item number). Each tool shall be tagged to indicate its intended use.

c. Insulation and Jacketing

1) Unless otherwise specified, the turbine shall be supplied with removable blanket-type acoustical or thermal insulation extending over portions of the casing that may reach a normal
operating temperature of 75°C or higher. The blanket shall consist of insulating material encapsulated in a high temperature fabric with protective wire mesh. Jacket fasteners, wire mesh, and fittings shall be made of stainless steel.

2) The insulation shall maintain a jacket surface temperature of not more than 75°C (165°F) under normal operating conditions. Jacketing and insulation shall be designed to minimize possible damage during removal and replacement.

2.09 COMBUSTION AIR PRE-HEAT COIL

A. Provide a combustion air pre-heat coil at the inlet of the forced draft fan. The coil shall be sized to heat the air from 0°F to 40°F at the maximum fan inlet CFM. The coil shall utilize 125 psig steam as the heating medium.

2.10 ECONOMIZER

A. The Vendor shall furnish, shipped loose for mounting on the Owner’s foundation, one (1) economizer arrangement complete with structural steel support (field assembly and welding as required), interconnecting single case duct from boiler gas outlet to economizer gas inlet, and interconnecting feedwater piping from economizer feedwater outlet to boiler feedwater. Economizer shall be designed for inlet flue gas temperature, and outlet flue gas and feedwater temperatures establish by the Vendor for optimal boiler system performance based on an inlet feedwater temperature of 228°F. Economizer shall be double cased and internally insulated. The economizer shall be manufactured by (Vendor to specify).

B. The economizer shall be designed so that access for tube inspection can be achieved by access door(s) in the economizer casing.

C. The economizer internal casing shall be a minimum of 10 ga. carbon steel seal welded, gas tight, and externally insulated with heavy duty blanket insulation, secured and externally lagged with corrugated, galvanized lagging. The entire economizer shall be covered by at least 14 ga. thick outer casing.

D. The gas side connections on the economizer shall be plate flange type with drilled bolt holes for aligning to adjacent components. The water side connections shall be flanged.
E. The economizer circuit shall consist of feed and check valves to the inlet headers and economizer tubes and interconnecting piping from economizer to the drum. An arrangement to manual bypass the economizer shall also be provided. This shall essentially consist of a bypass interconnection between the feed water inlet and outlet. All necessary mountings, fittings, drains, vents and pressure relief valves shall be provided. For measurement of the feedwater temperature at the economizer, the necessary provisions for local and remote temperature indication shall be provided. Instrumentation shall be provided by others. The unit shall incorporate lifting lugs to facilitate loading, unloading and rigging.

F. The design, fabrication and construction of the economizer shall be in accordance with ASME Code Section I.

G. The economizer shall be designed to in accordance the Vendor’s recommended water quality. The Vendor shall submit the recommended water quality.

H. The economizer shall be a non-steaming type.

I. With the specified fuel, it is anticipated that soot blowers are not required. However, based on the Vendor recommendation, the economizer shall be designed and constructed in the empty lanes to accept passage of soot blowing media later. In addition, wall boxes and distal bearings shall be provided on enclosure walls at strategic locations, so that if needed later, soot blowers can be retrofitted easily. All openings shall be suitably blanked to permit operation without soot blowers at present.

J. Spiral Fintube Economizers:
   1. The tube pitch shall be square to insure ease in cleaning.
   2. Fin Pitches -- (Specify):
   4. Fins shall be either welded or extruded. Tension wrapped, embedded, cast iron or brazed fintubes are not acceptable.
   5. Fin material may be carbon steel for all fin tip temperatures 900°F and cooler. Above 900°F fin tip temperature, alloy materials must be used.

K. Insulated manways, 16" minimum, shall be provided for access to all sootblower lanes. Such lanes shall be not less than 18" center to center of tubing.
2.11 ECONOMIZER PREHEATER

Each economizer shall be provided with a preheater to ensure the plants boiler feedwater to the economizer meets the requirements in paragraph 2.10. A shell and tube heat exchanger shall be designed and provided to be installed upstream of the economizer feedwater inlet. Vendor should inspect the existing plant conditions and arrangement of the existing economizer preheaters to ensure continuity of design.

2.12 FLUE GAS RECIRCULATION SYSTEM

A flue gas recirculation (FGR) system, for the boiler to meet the guarantee emission levels specified herein shall as a minimum, consist of:

A. Ductwork from the stack breaching to the FGR system fan, including stack connection, expansion joint, fittings and hardware.

B. Provide system fan, motor and drive. Fan motor shall be TEFC. Bearings shall be capable of high operating temperatures up to 650°F.

C. FGR damper to proportionally control NOx emissions from the boiler and shall receive a 4-20 ma signal provided by others.

D. Manual shutoff valve with limit switch for interlocking fan operation.

E. Burner design shall allow for mixing of combustion air, recirculated flue gas and burner gases.

F. Stack minimum flue gas temperature switch to prevent boiler from modulating until operational temperature is reached.

G. Timer controls for fan operation for cool down of this fan after boiler shutdown.

2.13 INSTRUMENTATION AND CONTROLS

A. Control Philosophy: The intent of the control system is for complete control and monitoring of the boiler system to be done in a remote control room and for local use only emergency stop and monitoring/status indication. In addition, the local panel shall permit startup personnel ease of access for system checkout. Thus it is the intention of this specification, that the Vendor terminate all wiring in local panel/junction box(es) for ease of connection to the remote panel.
All instrumentation and controls must be pre-approved by NYCDEP. Refer to the criteria book for detailed requirements such as requirement of make, model and catalogue sheets for each control unit.

B. All burner management controls for the boiler system shall be enclosed in a suitable cabinet, with hinged door and lock, containing all necessary relays, contactors, terminal blocks, fuse blocks, fuses, transformers, switches, and colored indicating lights. All instruments on the panel front shall be identified by nameplate. An alarm horn shall be provided on the remote panel to indicate flame failure and other trips, as well as a first-out annunciator. All wire terminations shall be numbered in accordance with the applicable wiring diagram. All wiring shall conform to the National Electric Code and authorities having jurisdiction.

C. Operating and Safety Controls: The unit shall be provided with a full complement of operating and safety controls, consisting of not less than the following items and features, which shall be shop assembled. Refer to paragraph 2.06H of this specification for details.

D. The following instrumentation shall be supplied by the Vendor:

1. Water column with water gage, water gage valves, trycocks, high and low water alarm switches, primary low water cutout, and auxiliary low water cutout in accordance with ASME Section I paragraph PG-60.1.

2. Provisions for a differential-pressure drum level transmitter;

3. Provisions for an economizer gas outlet pressure and temperature transmitters;

4. Provisions for an economizer gas inlet pressure and temperature transmitters;

5. Provisions for an economizer feedwater outlet temperature transmitter;

6. Provisions for an economizer feedwater inlet temperature transmitter;

7. Forced draft fan damper actuator including I/P transducer.

8. Feedwater level control valve with I/P transducer, positioner and 3-valve bypass for manual control of drum level.

9. Furnace pressure control damper actuator with I/P transducer with close limit switch.
10. Vortex flow meters for feedwater measurement.

11. All valves and field-mounted instruments shall be provided with a legible 1" diameter (min.) 304 stainless steel tag identifying its tag number. The Owner will provide a block of numbers for the Vendor’s use. The tag shall be fastened by a non-corrosive hook and chain.

E. Burner Management System:

The flame safeguard and safety system logic shall reside in an Allen Bradley CompactLogix programmable logic controller located in the Boiler Control Panel. The Boiler Control Panel shall be designed and manufactured in accordance with UL 508 by Preferred Utilities Manufacturing Corporation. All logic shall be designed and implemented on the PLC utilizing the following components in full accordance with the recommendations of FM, IRI, and NFPA 85. The Burner Management System must comply with pre-approval requirements of the NYCDEP. The Boiler Control Panel Manufacturer shall maintain spare boiler control panel components to reside in an office within a 75 mile radius of the hospital.

The BMS must be pre-approved by the NYCDEP.

1. Allen Bradley CompactLogix programmable logic controller with Ethernet module for communication to the customer SCADA system. From a single designated location, operations staff can monitor and manage both flame safeguard and the burner combustion control system. The BMS panel shall be mounted on the boiler front.

2. Redundant Watchdog Timers shall be provided to guard against processor, memory, I/O, and power supply failures.

3. Critical PLC Output Modules shall be monitored on a continual basis to assure they are in keeping with the sequence of operation. Failure of an output to pass continual testing shall result in an immediate shutdown of the system.

4. Critical PLC Input Modules shall be monitored at three second intervals. A failed input module shall result in the immediate shutdown of the system and the annunciation of the failed input card.

5. Reliable Low Water Cutout Operation shall be assured by PLC monitoring of
blowdown. During daily low water cutout blowdown, the PLC shall monitor the low water cutout interlock for successful operation without tripping the boiler. For manual blowdown, the message center warning alarm notifies the operator if daily blowdown fails to occur.

6. Redundant Fireye Insight, or equal, self-checking flame detection scanner and electronic relay complete with signal strength meters shall be provided.

7. A limit circuit consisting of the following limit switches, all wired so as to provide shutdown of the unit if an unsafe condition arises:
   
   a. High operating steam pressure switch.
   b. Excess high operating steam pressure switch.
   c. Forced draft fan interlock.
      d. Low fire start switch.
   e. High gas pressure switch.
   f. Low gas pressure switch.
      g. Low water level switch.
   h. Low atomizing steam pressure switch.
   i. Low atomizing steam flow switch.
   j. Low oil pressure switch.
   k. Auxiliary low water cutout.
   l. Low water cutout.
   m. High water cutout (if applicable)
   n. Low combustion air flow.
   o. Purge air flow switch.
   p. High furnace pressure (if applicable).
   q. Low instrument air pressure switch.
   r. Additional limit devices as required by FM and NFPA.

8. A damper position open and minimum position switch shall be provided to insure damper open during purge and at low fire during light-off.

9. Safety shutoff valves on both fuels shall be provided so as to meet IRI or FM insurance requirements. These safety shutoff valves shall be of the manual reset or fully automatic type, depending on desired boiler operation. Both fuels will use two safety shutoff valves in series. On gas fired units, an automatic vent valve shall also be used. The SSO valves shall close in less than 1 second. Each of the valves must have a proof of closure and open switch for BMS logic interface.
10. Provision shall be included so as to safely permit changing from one fuel to the other while the unit is at low fire without shutdown. This provision shall not permit operation with both fuels beyond a reasonable changeover time. The fuel changeover logic shall be per NFPA 85 requirement.

11. A graphical screen shall be provided for status of the burner including the following messages:

   a. System Off
   b. System Reset Required
   c. Hold for Permissive(s)
   d. Limits Made
   e. Hold for Purge
   f. Hold for Purge Position
   g. Hold for Low Fire Position
   h. Light-off Delay
   i. Purge in Progress, “X” Seconds Remaining
   j. Low Fire Switch Not Made
   k. Purge Position Switch Not Made
   l. Pilot Valves Energized
   m. Main Gas Valves Energized
   n. Main Oil Valves Energized
   o. Burner Released for Modulation
   p. Main Gas Firing
   q. Main Oil Firing
   r. Hold for Air Biasing (Low Fire Changeover Mode)
   s. Fuel Transfer In Progress
   t. Incorrect Transfer Mode
   u. Fuel Transfer Complete

12. An annunciator and alarm screen shall be provided to annunciate all limit outages, as well as, flame failure. The annunciator shall operate with a first out sequence type, and shall sound an alarm and annunciate first out. Subsequent outages will be indicated after acknowledging first out. The graphical annunciator will provide a first out feature and a test-read pushbutton. Subsequent outages will be indicated acknowledging first out. Annunciator will operate from single pole double throw limit switches. An alarm horn shall be installed so as to sound an audible alarm on shutdown by safety or limit circuit. Provision shall be made for silencing alarm horn, but to allow it to be sounded for any subsequent alarm.
A graphical screen serving as an annunciator shall be provided. As a minimum, the burner management system shall monitor, alarm, and trip the burner based on the following safety interlock switches:

a. Flame Failure, Scanner A  
b. Flame Failure Scanner B  
c. I/O Slot Failure  
d. High Gas Pressure  
e. Low Gas Pressure  
   f. High Water Alarm  
   g. Low Water Alarm  
   h. Low Water Shut-down  
   i. Aux Low Water Shut-down  
j. High Drum Pressure  
k. Excess High Drum Pressure  
l. High Furnace Pressure (if applicable)  
m. Low Oil Pressure  
n. Low Atomizing Steam Pressure  
o. Low Atomizing Steam Flow  
p. Low Instrument Air Pressure  
q. Low Combustion Air  
r. VFD Trip/Fail  
s. VFD Speed Feedback Deviation Trip

The remote-mounted burner combustion control panel (CCP) shall contain all devices required, including all control circuit breakers and fuses. No field wiring shall be required except from terminal blocks to external equipment. All electrical equipment shall be installed and tested at the factory, simulating complete operational sequence. All connections, terminals and wires shall be identified and marked with a number that can be cross referenced on a system drawing. This test may be witnessed by the Owner and/or the Engineer.

F. Combustion Controls:

1. General

This specification covers the manufacture, shop assembly, delivery and installation of the combustion and feedwater control systems with instrumentation as described in further detail. Each boiler shall be provided with a fully metered,
cross limited combustion control system complete with three-element feedwater control, and furnace pressure control, provided within a single floor-mounted Boiler Combustion Control Panel. The Combustion Control System controllers, one or more DCS-III programmable controllers by Preferred Utilities Mfg. Corporation, or equal, shall be displayed graphically on a 15" Operator Interface Touchscreen (OIT) Model OIT-15-TSF by Preferred Utilities Manufacturing Corporation or equal. The controllers and the Operator Interface Touchscreen shall be suitable for boiler room environment. (Preferred Utilities Burnermate TS, or equal).

All combustion controls must be pre-approved by NYCDEP and meet the criteria.

Design, construction and materials shall conform, as a minimum, to the following:

a. System components shall be of the electronic, solid state, microprocessor type. Equipment shall be conservatively designed to assure long life and reliability.

b. Controllers will contain large intuitive blockware configuration, 160 block memory with 18 I/O points as standard and available expansion up to 31 I/O each.

c. Dual Redundant memory modules to protect configuration data, tuning parameters, and operating status information. Configuration and calibration data shall be stored in a non-volatile EEPROM plug-in memory module. In addition, a redundant plug-in backup memory module shall be furnished that will automatically download into the primary memory in the event of primary memory data corruption.

d. The Controller shall utilize 120 VAC for discrete inputs and outputs to assure system compatibility.

e. Analog inputs shall be 1 - 5V or 4-20 mA DC. Analog input and output signals shall be isolated from earth ground for ground loop prevention.
f. The controller shall include optional TRIAC, 24-120 VAC solid state switch output boards to directly interface with electric actuators. Controller I/O quantities shall be expandable with plug-in I/O option cards.

g. Communication via Ethernet to the customer SCADA System.

h. Connections for analog signal wiring to field mounted equipment shall be made at terminal strips located on the termination panels using lugs and screw terminals.

2. Control Systems Diagram:

   a. Vendor shall submit a functional control diagram in either ISA or SAMA symbols. The diagram shall show each piece of equipment, properly tagged. The vendor shall be responsible for furnishing a complete complement of equipment to perform the functions shown on the functional diagram.

   b. Fully Metered, Cross Limited Control System Complete with Oxygen Trim Control:

   c. Each control system shall be of the fully metered, cross limited type complete with oxygen trim and three-element feedwater control. The combustion control system shall modulate in accordance to steam header pressure demand utilizing measurement of fuel and air, and arranged such that the fuel input can never exceed the available air (i.e. air shall lead fuel on load increase and fuel shall lead air on load decrease).

   d. No additional control strategy-logic will be allowed to slow down the control system response to load requirements to compensate for burner instability.

   e. A proportional plus reset controller shall be provided for each control loop including boiler master, natural gas, No. 2 fuel oil, combustion airflow and oxygen trim.

   f. The graphic screen shall have a dedicated M/A station for each control loop shall be provided to permit operator manual control.

3. Feedwater Control System:
a. Drum level shall be maintained using three variables, feedwater flow, steam flow and water level. The drum level is controlled by a controller that receives a signal from a drum level transmitter. This signal is compared to a setpoint. Steam flow shall modify the signal. The output signal is sent to an operator station to permit manual control of the level by operating the feedwater control valve.

b. A proportional plus reset controller shall be provided for the drum level control.

c. Dedicated M/A station for drum level shall be provided to permit manual control.

d. A feedwater control valve shall be provided. The feedwater valve shall be a Fisher fig. No. 657.

4. Coordination with Burner Management System:

The combustion control system shall be integrated with the burner management system, by a single manufacturer regularly engaged in this type of work, to assure a low fire start and a complete purge without fuel flow.

5. Graphic Screen Trending

The following points will be trended (except as noted) on the OIT Screen:

a. Boiler Steam Flow, PPH
b. Total Steam Flow (indicated only, not trended)
c. Feedwater Flow, PPH
d. Total Feedwater Flow (indicated only, not trended)
e. Drum Level, %
f. Steam Drum Pressure, psig
g. Firing Rate, %
h. Stack O2, %
i. Gas Flow, SCFH
j. Total Gas Flow (indicated only, not trended)
k. Oil Flow, GPM
l. Total Oil Flow (indicated only, not trended)
m. Furnace Pressure, inches of w.c.
n. Economizer Feedwater Inlet Temperature, °F
o. Economizer Feedwater Outlet Temperature, °F
p. Economizer Inlet Flue Gas Temperature, °F
q. Economizer Outlet Flue Gas Temperature, °F
r. FGR Flow, PPH
s. FGR Temperature, °F
t. Combustion Air Flow, SCFM
u. Combustion Air Temperature, °F
v. Boiler Efficiency, %

6. Manufacturer’s Recommendations:

Where installation procedures or any part thereof, are required to be in accordance with recommendations of the manufacturer of the material being installed, furnish five printed copies of these recommendations prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations shall be cause for rejection of the material.

7. Wiring:

All wiring associated with and required for the system shall be the responsibility of the vendor (or system integrator). The term "wiring" shall be construed to include furnishing of wire, conduit, miscellaneous material and labor as required to install a total working system. All field wiring shall run between like numbered terminals at each end.

8. Standard Products:

Materials and equipment shall be catalog products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer’s latest standard design that complies with specification requirements. Where two units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of a single manufacturer. Each major component of equipment shall have the manufacturer’s name and address and the model and serial number on a permanent nameplate securely attached in a conspicuous place.

9. Control Valve Selection Responsibility:
The controls vendor shall be responsible for coordinating the sizing of the boiler fuel control valves to assure accurate operation and interface with control loops, indicators, and alarms as specified elsewhere.

10. Submittals:
   a. Control loop diagrams in either ISA or SAMA symbols. The diagram shall show each piece of equipment properly tagged.
   b. Descriptions of control functions.
   c. Performance data.
   d. Documented description of components.
   e. Flow meter and valves.
   f. Arrangement of control panel accessories, valves, etc.
   g. Catalog cuts.
   h. Certification that system is complete arrangement of control panel.
   i. Control System Architectural Diagram with details.

11. Sequence of Operation:

   General:

   All control loops shall have a separate controller that includes manual/automatic (M/A) stations to provide for control of the system. Each M/A station shall contain a built-in indicator to show flow, temperature of other variables being controlled in graphic form.

   a. Existing Plant Master:

       An existing Plant Master controller receives a pressure signal from pressure transmitter located on the common steam header to all boilers. The Plant Master generates a signal to drive all boiler master controllers, on demand for steam input to the system. The existing “Plant Master Controller” (PMC) is presently located in the “Boiler #4 Combustion Control Panel” (CCP). It shall be relocated to Boiler #2 CCP and setup to operate for Boilers #1 and #2 prior to demolition of Boilers #4 and #5. The vendor shall furnish and install a new PMC to replace the existing one. The new PMC shall be installed in the new Boiler #4 CCP. The vendor shall provide complete design interface of the new PMC with the four boilers controls.
b. **Individual Boiler Control:**

The signal from the plant master shall drive each boiler master. Boiler load is displayed on the control. The steam pressure is compared to a selected setpoint. The controller shall either increase or decrease the burner firing rate based on the comparison of the setpoint.

c. **Fuel Control:**

1. A separate A/M fuel station shall be provided for each fuel fired.

2. Natural gas flow and steam flow is measured using a vortex meter, manufactured by Rosemount or equal, and sends 4-20 MADC signal to a dedicated flow controller. The output signal of the dedicated flow A/M station drives the control valve. Both steam flow and gas flow shall be provided with pressure and temperature compensation.

3. Oil flow is measured using a coriolis positive displacement oil flow meter, manufactured by Micromotion, or equal, and sends a 4-20 MADC signal to the dedicated oil flow controller. The output signal of the oil flow A/M station drives the control valve.

4. An interruption in circuitry between the controllers and fuel valves will be under the control of the burner management system to assure that the boiler will start under low fire conditions.

d. **Airflow Control:**

Airflow is controlled by an air flow monitoring station that receives a signal from the airflow transmitter. Airflow is shown as a percentage on the graphic display. Actual flow, after adjustment by the oxygen trim controller, is compared to the selected signal from the boiler master and fuel flow signal. The difference drives the variable frequency drive.

e. **Oxygen Trim:**

1. A system shall be furnished to provide automatic adjustment of the fuel to air ratio based on the oxygen content in the flue gas. The oxygen control system shall include the following functions as a minimum:
2. A dedicated air flow monitoring station to program the oxygen setpoint for each fuel as a function of boiler load.

3. An in-situ oxygen analyzer shall be provided for installation in the boiler outlet ducting to measure the flue gas oxygen content.

4. An in-situ oxygen analyzer, manufactured by Rosemount, or equal, shall be provided for installation in the burner windbox to measure the windbox oxygen content.

12. Basic System Structure:

a. The system provided shall be microprocessor-based single loop controllers which perform all the control functions normally furnished in a conventional analog process control system.

b. It shall provide easy and conventional operator interface to the process, provide high system reliability, quick and easy maintenance accessibility, and it shall allow the operator complete individual control of all final elements under any failure mode without the need for a redundant backup system.

c. The controllers shall be manufactured and labeled in accordance with UL508A (CSA C22.2 #14 for use in Canada). Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL). Lack of an NRTL certified UL508A wiring methods inspection and labeling will be grounds for controller rejection.

d. Each basic Controller shall be a completely self-contained stand-alone unit requiring no auxiliary equipment.

e. Each basic controller shall be a microprocessor-based controller that can operate independently. The controller shall provide for balanceless-bumpless transfer. In normal operation, this unit receives analog inputs, calculates the output and positions the associated final control element. Plug-in field wiring shall allow removal of the controller circuit boards without disconnecting any panel or field wiring from the terminal strips.
f. Control strategy shall be free from “Blockware” type language. The controller shall be supplied with an onboard library of 61 analog and discrete functions and have a minimum 160 block memory. Configuration shall also be capable of entering via a lap top computer or a computer station. Configuration and tuning shall be password protected. Any quantity or combination of function blocks (AIN, PID, LOALM, F(x), etc.) shall be easily copied into a control strategy and “wired” from block to block. The controller shall be capable of calculating real time boiler efficiency based on the ASME “by losses” method. The calculation must utilize real time inputs of boiler firing rate, flue gas Oxygen, flue gas temperature and fuel selected. Two sets of adjustable fuel chemistry data parameters shall be included, and firing rate scaled radiation losses shall be used for maximum accuracy. Calculations that rely on fixed constants or manually entered values for these conditions are not acceptable. Fuel/Air ratio curve and Oxygen trim setpoint curve adjustment shall be automated for rapid, error-free burner setup. Only a single operator action shall be required to store commissioning data into multiple characterizer curves for a particular load point. Each controller shall be completely field configurable from the front panel keypad without the use of external computers or hand-held terminals. Configuration changes, tuning, and Oxygen trim setpoint curve adjustment shall be accomplished via a keypad on the controller front panel or the 15” Operator Interface Touchscreen (OIT).

g. The CCS shall be designed with communication capabilities to interface with a (SCADA) System without requiring significant equipment modification or extensive field wiring. Ethernet communication is the preferred method.

h. The unit shall be capable of displaying variables in engineering units.

1. Combustion Control System Monitoring Points:

   As a minimum, the Control System will be designed to monitor the following:

   a. Combustion Air Flow
   b. Force Draft Fan VFD
   c. Fuel Gas Flow
   d. Fuel Oil Flow
2. Combustion Control System Control Points:

As a minimum, the Control System will be designed to control the following:

a. Air Flow Damper
b. Fresh Air Damper
c. FGR Valve
d. Fuel Gas Flow Control Valve, Primary and Secondary (if required)
e. Fuel Oil Flow Control Valve
f. Force Draft Fan VFD
g. Boiler Draft Damper
h. Feedwater Valve
i. Atomizing Steam Differential Pressure Control Valve

3. Pressure and Differential Pressure Transmitters:

a. Construction shall be of the rugged type, designed for industrial applications. Body shall be stainless steel and shall be weatherproof.

b. Pressure Sensing Element - element shall be of the deposited strain gauge type actuated by a Hastelloy "c" Pressure Capsule.

c. Electrical Design

d. Transmitters shall be compatible with a 2-wire system.
e. Transmitters shall be of the SMART type.

f. Transmitter shall be intrinsically safe when used in conjunction with energy limiting barriers.

g. Transmitter shall operate with any regulated DC power source between 15-50 volts.

h. Signal Range - output signal range shall be of 4-20 MA DC analogous to pressure range.

i. Amplifiers - Amplifiers shall be interchangeable between pressure transmitters.


l. Indicating transmitters shall be furnished. Scales on indicating type shall be in engineering units.

m. Calibration - transmitters shall incorporate electrical adjustments of range and zero.

n. Accuracy - transmitters shall be accurate to 0.25% of range span.

o. Mounting - transmitters shall be suitable for surface or 2" pipe mounting.

p. Transmitters shall be provided for the following points:

1. Combustion Air Flow
2. Furnace Pressure
3. Boiler Drum Level
4. Boiler Steam Flow
5. Steam Drum Pressure
6. Feedwater Pressure
7. Fuel Oil Pressure
8. Natural Gas Pressure
9. Atomizing Steam Pressure
10. Windbox Pressure
11. Boiler Flue Gas Outlet Pressure
12. Economizer Outlet Flue Gas Pressure
13. Instrument Air Pressure
q. Differential Pressure Transmitters shall be provided with a 5-valve manifold manufactured by Rosemount, or equal.

r. Temperature Transmitters (Manufactured by Rosemount, or equal):

1. Construction - construction shall be rugged type, designed for industrial application. Unit shall be weatherproof.


3. Electrical Design

   a. Transmitters shall be compatible with two wire systems.
   b. Transmitters shall be of the SMART type.
   c. Transmitters shall be intrinsically safe when used in conjunction with energy limiting barriers.
   d. Transmitters shall operate with any regulated D.C. power source between 15-50 volts.
   e. Signal Range - output signal range shall be 4-20 MA DC analogous to temperature range.
   f. Transmitters shall have RFI (Radio Freq. Interference) filtering.

4. Indicating or Non-Indicating Design - transmitters shall be indicating or non-indicating as specified for particular transmitters. Scales on indicating type shall be in engineering units.

5. Calibration

   a. Transmitters shall incorporate electrical adjustment of range span and zero.
   b. Transmitter shall be capable of being calibrated with output direct or inverse with respect to input.

6. Accuracy - Transmitters shall be accurate to within .1% of temperature range (with 10 v span).

7. Cold Junction Compensation - Transmitter shall include automatic cold-junction compensation.
8. Thermocouple Burnout Protection - Transmitter shall be capable of
driving the output either upscale or downscale in the event of
thermocouple burnout.

9. Mounting - Transmitter shall be suitable for surface or 2" pipe
mounting.

10. Transmitters shall be provided for the following points:

   a. Boiler Outlet Flue Gas Temperature
   b. Economizer Outlet Flue Gas Temperature
   c. Economizer Inlet Feedwater Temperature
   d. Economizer Outlet Feedwater Temperature

s. Elements:

1. Vortex shedding meter shall be provided for the measurement of
   natural gas flow, feedwater flow and steam flow. Each vortex
   meter shall be furnished with ANSI RF flanges. The vortex
   meter shall be sized to provide a 10:1 turndown. A 4-20 MADC
   output signal shall be provided to the combustion control system
   that is proportional to the measured flow. The gas and steam
   Vortex meters shall be provided with pressure and temperature
   compensation.

2. Oil flow shall be measured using a Coriolis positive displacement
   meter. The meter shall be sized to provide proper turndown to
   match the operation of the burner. A 4-20 MADC output signal
   shall be provided to the combustion control system that is
   proportional to the measure flow.

t. Feedwater Control Valve:

1. Operation of valve shall be controlled automatically by the
   feedwater control system. In addition, the valve shall have a
   normally open action.

2. A valve mounted positioner shall convert the 4-20 MA signals sent
   from the control room to an air signal.
3. Control air will actually position the valve via diaphragm position. Control air pressure shall be actuated by a signal from the transducer.

4. The valve shall be of the globe type, suitable in all respects for the required operating conditions.

5. The valve body shall be made of cast iron to be held by adjoining flanges.

6. Valve shall be similar to Fisher 657 ED.

v. Natural Gas Control Valve:

1. Operation of valve shall be controlled automatically by the combustion control system and shall include a low fire position switch.

2. A valve mounted positioner shall convert the 4-20 MA signals sent from the control room to an air signal.

3. Control air will actually position the valve via diaphragm position. Control air pressure shall be actuated by a signal from the transducer.

4. The valve shall be of the ball type design, suitable in all respects for the required operating conditions.

5. The valve body shall be made of cast iron to be held by adjoining flanges.

6. Valve shall be similar to Fisher V-Ball 150.

7. Valve shall be sized to provide a 10:1 turndown to match the operation of the burner.

v. Fuel Oil Control Valve:

1. Operation of valve shall be controlled automatically by the
2. A valve mounted positioner shall convert the 4-20 MA signals sent from the control room to an air signal.

3. Control air will actually position the valve via diaphragm position. Control air pressure shall be actuated by a signal from the transducer.

4. The valve shall be of the globe type, suitable in all respects for the required operating conditions.

5. The valve body shall be made of cast iron to be held by adjoining flanges.

6. Valve shall be similar to Fisher 667.

7. Valve shall be sized to provide an 8:1 turndown to match the operation of the burner.

w. Torque Type Drive Units - Electronic Input:

1. The drive unit shall be sized to have a continuous available torque as required by the application based on an available 100 psig power air supply and shall be operable without damage up to 120 psig air supply.

2. The drive units shall have a repeatability of 0.5% of full scale and a sensitivity of 0.5% of full scale. Speed of response shall be 3 to 10 second depending on the size of the cylinder.

3. All units shall be suitable for inside installation with continuous operation in an ambient temperature of +40 Deg. F to +140 Deg. F. (4.44C to 60C) without a heater. Drive units shall be operable up to a relative humidity of 100%.

4. Units shall be provided to receive any of the following input signals: 4-20 ma electronic
5. Rotary drive units shall include an angular position indicator. Manual levers shall be provided when specified to permit manual positioning of the damper under full load conditions.

6. Auxiliary limit or position switches shall provide isolated contacts and shall be fully adjustable from minimum to maximum drive lever stroke. Contact rating shall be: 15 amps - AC or 62.5 VA DC.

7. Control torque to be a minimum of 90 ft. lbs. with a stall torque of 120 ft. lbs.

8. Unit to be Bailey Model UP10 or equal, complete with electro-pneumatic transducer. Servo motor drive is acceptable and must have position feedback.

9. Drives shall be provided for the following dampers:
   
   a. Fan Inlet Vane Damper (if required with VFD to meet burner turndown)
   
   x. Oxygen Analyzer - In Situ Type:

   1. The oxygen analyzer shall be of the direct probe type utilizing a Zirconia oxide sensing element with 4 year minimum life, a ceramic heater with thermocouple. A sensing element filter must be provided in the probe assembly to prevent dust and dirt from contaminating the sensing element.

   2. The analyzer shall be equipped with a facility to allow "in place" calibration check without removing the analyzer from the process.

   3. The probe assembly must be stainless steel and all wetted parts must be grade 304 stainless steel minimum. Probe flange shall be ANSI 125# flange.

   4. The analyzer as described will be capable of operating in flue gas temperatures up to 1150 degrees F.

   5. The power source shall be 120 volts AC. The output of the system shall be 4 to 20 MA DC, representing percent O2 as a linear function.
6. Analyzer displays shall be readable in the Boiler Control Panel Operator Interface Touchscreen (OIT-TSF).

7. Oxygen Analyzer shall be Preferred Utilities Manufacturing Corporation Model ZP or equal

Panel:

1. One free-standing mounted control panel shall be provided with each burner complete with the equipment described above.

2. Construction:
   a. Panels shall be of the rear access type, constructed of steel sheets selected for flatness and finish.
   b. Fabrication shall be all welded construction with minimum radius corners, stiffened as required and framed with angles.
   c. All mounted instruments shall be properly supported front and rear.
   d. Steel thickness, front and sides, shall be 7 gauge. The top cover and rear shall be No. 11 gauge.
   e. Panel mounted holes shall be provided in the channel panel base suitable for fastening panel in place. Panels shall be furnished with removable lifting eyebolts.
   f. Panel shall be sandblasted inside and out to remove mill scale, welding slag, and oil residues before finishing.
   g. Panel shall be primed with an undercoat suitable for proper bonding of the finish coat.
   h. The exterior of the panel shall be finished with textured polyurethane enamel type paint. This paint shall be of the air-dry type, color as selected. The interior of the panel shall be finished with white enamel with a smooth finish.
3. Panel Wiring:

a. Wiring shall comply with the acceptable standard panel practice. The 120 volt, 60 Hz circuit wiring shall be number 16 AWG minimum, THWN 600 volt insulation, color-coded. Signal circuits, less than 50 volts, number 18 AWG minimum; PVC insulated, or number 20 AWG in multi-conductor cable.

b. Each device requiring power shall be wired so that when wires are removed from any one device, power will not be disrupted to any other devices.

z. Installation:

1. The vendor shall provide a turnkey installation of the controls to include, but not limited to the following items:

a. Removal of existing combustion and feedwater controls including panels, control valves, flow meters, analyzers, actuators, indicators, etc.

b. Mounting and piping of new control valve instrumentation supplied including panels, control valves, flow meters, analyzers, actuators and miscellaneous devices required.

c. Wiring of new control valve instrumentation supplied including panels, control valves, flow meters, analyzers, actuators and miscellaneous devices required.

d. Wiring of forced draft fan to variable frequency drives.

e. Piping of instrument air to miscellaneous control devices including control valves, analyzers and actuators.

f. Supporting of installed piping and conduit.

g. Mechanical and electrical checkout of all installed equipment in preparation for burner startup and testing.
h. The Vendor shall provide "Instrument Installation Details" for review and approval.

2. A fully-metered combustion control system shall be provided to adjust the air and fuel flowrates. However, all final control elements for components, such as control valves and dampers, shall be provided by the Vendor.

3. The following components shall be supplied by the Vendor as part of this system:
   a. One (1) natural gas control valve complete with low-fire limit switch, pneumatic actuator, positioner, and I/P converter.
   b. One (1) fuel oil control valve complete with low-fire limit switch, pneumatic actuator, positioner, and I/P converter.
   c. One (1) No. 2 oil coriolis flow meter assembly for measuring oil flow to the boiler, including meter, 4-20 ma dc transmitter and upstream wye strainer with blowoff with element sized to protect meter in accordance with manufacturer’s recommendations.
   d. One (1) piezometer tube assembly for air flow measurement, installed by the Vendor in the FD fan inlet silencer assembly; one (1) associated differential-pressure transmitter will be supplied and installed by others.

4. The following signals (dry contacts) shall be supplied by the Vendor for interface with the combustion control system:
   a. Go to Purge Position
   b. Master Fuel Trip
   c. Release to modulate

   aa. Forced Draft Fan

All safety interlocks required in accordance with FM and NFPA-8501 shall be provided by the Vendor and controlled by the Vendor’s burner.
management system.

bb. Oxygen Trim:

1. An oxygen trim system shall be supplied by the Vendor, as part of a fully-metered combustion control system, to enhance the ability to maintain the required fuel/air/FGR ratio.

2. The Vendor shall provide one (1) four-inch 150 lb. flat-faced flanged connection on the furnace outlet breaching for use by the Engineer for oxygen measurement for this system.

cc. Alternate Option Pricing:

The vendor shall provide the following option pricing:

1. Option 1: furnish, install, wire and commission for each boiler three (3) Rosemount multipoint recorders (front panel mounted). The process variables to be monitored shall be the identical to Boilers #1 and #2.

2. Option 2: The Vendor shall furnish as Preferred Utilities, or equal, SCADA system to replace the existing one in the Boiler Control Room. Two operator workstations shall be provided. The SCADA system shall have the capability of monitoring all four (4) boilers (BMS and CCS) and their auxiliaries, and shall have the capability to remotely control the boilers.

3. Option 2: The Vendor shall provide pricing for a Rosemount SCADA (Delta-V System) with the same requirements defined in Option #2.

2.13 ELECTRICAL

A. Motors shall be selected in accordance with the driven equipment requirements and as specified herein. The continuous nameplate rating shall be 15% greater than the maximum brake horsepower required by the driven equipment. Service factor ratings shall not be used to meet this requirement.

B. The Vendor shall be completely responsible for the selection and application of the motor drives, so that the driven equipment shall perform satisfactorily under the specified conditions. The design and construction of all motors shall be fully
coordinated with the mounting arrangement, alignment, connection, end play, direction of rotation, vibration and other applicable requirements of the driven equipment.

C. Motor performance shall be coordinated with the required performance of the driven equipment. All motors shall have ratings suitable for the torque and WK2 characteristics of the driven equipment. The design letter shall be in accordance with NEMA Standard MG1-1.12, and shall be furnished with the Motor Data Sheets.

D. All ac motors 1/2 to 250 hp shall be high-efficiency, constant-speed, squirrel-cage induction, TEFC, severe-duty (mill and chemical) type, rated 460 V, 3-phase, 60 Hz, with Class F insulation, and a 1.15 service factor. The motors shall have a corrosion-resistant nameplate, re-greasable fittings, oversized conduit box and a corrosion-resistant paint system. Temperature rise above 40°C ambient throughout the motor shall not exceed NEMA specified values. Motors shall be designed, manufactured and tested per ANSI/NEMA Standards. The full-load efficiency index letter and power factor shall be stamped on the nameplate.

E. Fractional-horsepower motors smaller than 1/2 hp shall be rated 120 V, single-phase, 60 Hz. Motors shall be totally enclosed, fan cooled, with Class "B" insulation or better and suitable for indoor/outdoor use.

F. All dc motors shall be rated 120 V, and shall be able to operate within a voltage range of 105 to 140 V dc.

G. All AC motor-operated valves shall be rated 460 V, 3-phase, 60 Hz, regardless of horsepower.

H. Motor terminal box shall be provided with grounding terminals.

I. Motors shall be painted per the manufacturer's standards.

K. All motors shall be designed to provide a continuous horsepower output, equal to the rated horsepower multiplied by the 1.15 service factor, without exceeding the total limiting temperature rise for the insulation system and enclosure specified.

L. All motors shall have a safe stall time equal to or greater than the maximum accelerating time under the minimum starting voltage conditions.
M. Starting current at full-voltage shall not exceed 650% of the motor full-load current for all ac motors. DC motors shall be rated for use with starters that limit the starting current to a maximum of 400% of motor rated full-load current.

N. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.14 CLEANING, PACKAGING AND TAGGING

A. All vessels, components and subassemblies shall be thoroughly cleaned of all water, sand, grease, oil and other foreign materials prior to shipment.

B. Flanged openings shall be provided with metal closures at least 5-millimeters thick, with rubber gaskets and at least four full-diameter bolts. For studded openings, all nuts needed for the intended service shall be used to secure closures. Each opening shall be car sealed so that the protective cover cannot be removed without the seal being broken.

C. Threaded openings shall be protected with end caps or or round-head plugs. In no case shall non-metallic (such as plastic) caps or plugs be used.

D. All caps, plugs and flange covers shall be sealed with tape to provide a dust-tight closure.

E. Exposed shafts and shaft couplings shall be wrapped with waterproof, moldable waxed cloth or volatile-corrosion inhibitor paper. The seams shall be sealed with oil-proof adhesive tape.

F. Turbines that have carbon rings shall be shipped with the rings installed. The vendor shall indicate in the instruction manual if the carbon-ring gland housing must be cleaned before initial start-up.

G. One copy of the manufacturer’s standard installation instructions shall be packed and shipped with the equipment.

H. Connections on auxiliary piping removed for shipment shall be match marked for ease of reassembly.
I. The equipment shall be suitably skidded, crated, boxed, sealed or otherwise protected from damage during shipment.

J. Each separate shipping crate, box or skid shall be clearly and indelibly labeled with equipment tag numbers. Letters shall be a minimum of 1" high.

K. Each piece of equipment identified with an equipment number shall have a 304 stainless steel nameplate permanently attached to it.

1. The nameplate shall contain the following information:
   a. Equipment number.
   b. Purchase order number and date fabricated.
   c. Manufacturer's name and address.
   d. Manufacturer's serial number and model number.
   e. Equipment Data: Maximum working pressure and temperature, operating volume, etc.

   2. All information shall be embossed on the nameplate or otherwise permanently affixed.

   3. Motor nameplates shall be the responsibility of the Vendor and shall contain the motor manufacturer's standard information.

L. The cleaning and packaging requirements of this section are minimum standards to be followed. The Vendor shall submit in writing, his standard procedures for cleaning and packaging for Engineer's review. In addition, he shall submit written recommendations for field storage, both indoor and outdoor.

2.15 PAINTING

A. All components with carbon steel and iron surfaces shall be painted with one coat of zinc primer, followed by one finish coat of enamel. High temperature aluminum paint shall be used for uninsulated boiler components. Prior to painting, all surfaces shall be sandblasted to SSPC-SP6 or SP-3 as applicable. Color to be Vendor’s standard. The Vendor shall include a suitable amount of paint for each finish coat for field touch-up work.

PART 3 - EXECUTION

Not Applicable.
PART 4 – PERFORMANCE REQUIREMENTS

4.01 REQUIRED OPERATING CONDITIONS

A. The boiler shall be rated to generate on a continuous basis 120,000 lbs/hr of dry, saturated steam at 150 psig pressure when burning either natural gas or No.2 fuel oil at the discharge of the steam drum second isolation valve, when supplied with feedwater at 228°F at the economizer inlet and with a maximum continuous surface blowdown from the steam drum of 3 ppm with a boiler water solids concentration of 3000 ppm or less. The following fuel analysis shall be used:

**No. 2 Fuel Oil**

<table>
<thead>
<tr>
<th>Component</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTU</td>
<td>19,300 BTU/LB</td>
</tr>
<tr>
<td>Carbon</td>
<td>87.0% by wt.</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>12.5% by wt.</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.02% by wt.</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.02% by wt.</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.18% by wt.</td>
</tr>
</tbody>
</table>

**Natural Gas**

<table>
<thead>
<tr>
<th>Component</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTU</td>
<td>1000 BTU/Cu. Ft.</td>
</tr>
<tr>
<td>Methane, CH₄</td>
<td>90% by volume</td>
</tr>
<tr>
<td>Ethane, C₂H₆</td>
<td>5% by volume</td>
</tr>
<tr>
<td>Nitrogen, N₂</td>
<td>5% by volume</td>
</tr>
</tbody>
</table>

B. The boiler shall be provided with an adequate economizer section to reduce the
temperature of the flue gases leaving the economizer to at least 20°F above the acid and water dew points, under all operating conditions.

C. The combustion equipment and systems shall be designed with FGR to simultaneously achieve the below emission levels of particulate and gaseous products from a minimum of 25% to 100% load when the boiler is in operation on natural gas per the attached fuel data. Guaranteed emission levels as stated below shall not exceed the following maximum values, expressed as lbs./MMBTU (HHV) of fuel fired or percentage for opacity:

\[
\begin{align*}
\text{NOx} & = 0.08 \text{ lbs./mmBTU (HHV)} \\
\text{CO} & = \text{Vendor to specify (no greater than equivalent 100 ppmv at 3% O}_2) \\
\text{UHC} & = \text{Vendor to specify} \\
\text{NMHC} & = \text{Vendor to specify} \\
\text{PM-10} & = \text{Vendor to specify} \\
\text{TSP} & = \text{Vendor to specify} \\
\text{VOCs} & = \text{Vendor to specify} \\
\text{PM-10} & = \text{Vendor to specify} \\
\text{TSP} & = \text{Vendor to specify} \\
\text{VOCs} & = \text{Vendor to specify} \\
\text{Capacity} & = \text{Vendor to specify}
\end{align*}
\]

The Vendor shall specify in his proposal the maximum nitrogen content (% by weight) acceptable to meet the above NOx guarantee, without the addition of FGR if not already required.

D. The Vendor shall provide, combustion equipment and flue gas recirculation system that are designed to achieve the lowest emission level of particulate and gaseous products at the current best achievable technology (BAT). The Vendor shall provide guaranteed emission levels, for products as stated above, expressed as lbs./MMBTU (HHV) of fuel fired or percentage for opacity, for operation on both fuels.

E. The requirement of excess air at MCR condition shall be as follows:
Natural Gas: Not exceeding 10%
No. 2 Fuel Oil: Not exceeding 15%

F. The minimum thermal efficiency at MCR condition, as defined by PTC 4.1, shall be as follows:

- Natural Gas 83.38% (based on fuel HHV)
- No. 2 Fuel Oil 86.69% (based on fuel HHV)

G. The minimum turndown ratio for the Vendor-supplied components shall be as follows:

- Natural Gas 10 to 1
- No. 2 Fuel Oil 8 to 1

The following are minimum requirements with regards to utilities and flue gas content at full fire:
1. Acceptable backpressure burning gas 0.0” in.H2O, or psia
2. Exhaust temperature burning gas 350 degrees F, 177 degrees C
3. Exhaust gas flow rate burning gas 130,320 lbs/hr
4. Exhaust gas density burning gas 0.0485 lb/ft³
5. Exhaust gas viscosity burning gas 0.272 cP
6. Acceptable backpressure burning oil 0.0 in.H2O, or psia
7. Exhaust temperature burning oil 365 degrees F, 185 degrees C
8. Exhaust gas flow rate burning oil 130,390 lbs/hr
9. Exhaust gas density burning oil 0.0497 lb/ft³
10. Exhaust gas viscosity burning oil 0.26 cP
11. Natural gas: 146,740 SCFH @ 15 PSIG
12. No. 2 oil: 16 GPM @ 160 PSIG
13. Pilot gas: 1000 SCFH @ 15 PSIG (tapped of main gas line) / 1000 SCFH @ 3-5 PSIG
14. Atom. Steam: 1200 lbs./hr @ 150 PSIG
15. Combustion air: 123,590 lbs./hr @ 20” w.c.
16. Flue gas recirc: 22,250 lbs./hr @ 20” w.c. (not included in combustion air)
17. Tubeside Feedwater: 123,600 lbs./hr @ 200 PSIG
18. Shell side fluid entering: 150,170 lbs/hr
19. Feedwater temperature in: 227 deg F
20. Feedwater temperature out: 527 degrees F
21. Tubeside pressure drop: 10.57 psig
22. Shell side pressure drop: 1.44 in w.c.
23. NOX concentration: 0.08 lbs / MMBtu (without SCR)
24. CO2 concentration: At least 12.5%

END OF SPECIFICATION
FIRE-TUBE BOILERS
SECTION 235239 - FIRE-TUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled boilers, trim, and accessories for generating hot water or steam with the following configurations and burners:
   1. Horizontal, fire-tube or Vertical, fire-tube or Fire-box boiler.
   2. Combination gas and oil burner.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. UL Compliance: Test Boilers for compliance with UL 726, "Oil-Fired Boiler Assemblies" and UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Boilers to have a NYC MEA #.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. Startup service reports.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:
   1. Burnham Hydronics.
   2. Cleaver-Brooks; div. of Aqua-Chem, Inc.
   3. Easco –A.L. Eastmond
   4. Fulton Boiler Works, Inc.
2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, assembled, and tested, horizontal, fire-tube boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water supply and return connections, and controls.

B. Pressure Vessel Design: Straight, steel tubes welded into steel headers. Four passes with wet-back design. Minimum heat-exchanger surface of 5 sq. ft./bhp. Include the following accessories:

1. Hand-holes for water-side inspections.
2. Lifting lugs on top of boiler.
3. Minimum NPS 1 hose-end drain valves at shell low point.
4. Tappings or flanges for supply- and return-water piping.
5. Built-in air separator.
6. Accessible drain and blow-down tappings, both high and low, for surface and mud removal.
7. Tappings for steam supply, makeup, level controls, and chemical treatment.

C. Front and Rear Doors:

1. Davited, sealed with heat-resistant gaskets and fastened with lugs and cap screws.
2. Designed so tube sheets and flues are fully accessible for inspection or cleaning when doors are open.
3. Include observation ports in doors at both ends of boiler for inspection of flame conditions.
4. Door refractory shall be accessible for inspection and maintenance.

D. Casing:

1. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the boiler shell.
2. Flue Connection: Flange at top of boiler.
4. Mounting base to secure boiler to concrete base.
a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

5. Control Compartment Enclosure: NEMA 250, Type 12

E. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer having a minimum 3-1/2-inch-diameter dial.

2.3 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, vertical, fire-tube boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water supply and return connections, and controls.

B. Pressure Vessel Design: Straight, steel pipe welded in a concentric pattern to separate flue-gas and heating media to form four passes with welded fins to improve heat transfer in secondary flue-gas passages. Include the following accessories:

1. Hand-holes for water-side inspections.
2. Lifting lugs on top of boiler.
3. Minimum NPS 1 hose-end drain valves at water passage low point.
4. Tappings or flanges for supply- and return-water piping.
5. Built-in air separator.
6. Accessible drain and blow-down tappings, both high and low, for surface and mud removal.
7. Tappings for steam supply, makeup, level controls, and chemical treatment.

C. Combustion Chamber: Equipped with flame retainer to lengthen flame-residence time.

D. Casing:

1. Insulation: Minimum 4-inch- thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber.
2. Flue Connection: Top connection, constructed of aluminized steel.
4. Mounting base to secure boiler to concrete base.
a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

5. Control Compartment Enclosure: NEMA 250, Type 12

E. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer having a minimum 3-1/2-inch-diameter dial.

2.4 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, fire-box boilers with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water supply and return connections, and controls.

B. Pressure Vessel Design: Straight, steel tube welded into steel headers. Three passes with wet-back design. Minimum heat-exchanger surface of 5 sq. ft./bhp. Include the following features and accessories:

1. Tube Size and Thickness: Minimum NPS 2, minimum 0.105 inch thick
2. Brass washout plugs.
3. Steel turbulators.
4. Lifting lugs on top of boiler.
5. Minimum NPS 1 hose-end drain valves at shell low point.
6. Tappings or flanges for supply- and return-water piping.
7. Built-in air separator.
8. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.

C. Combustion Chamber: Welded steel, water-leg design with refractory insulation poured in the floor. Flame observation port.

D. Casing:

1. Insulation: Minimum 2-inch thick, foil-backed, mineral-fiber insulation surrounding the boiler shell.
2. Insulated removable smoke boxes and reversing chamber cover.
3. Flue Connection: Steel top or rear.
5. Control Compartment Enclosure: NEMA 250, Type 12.
6. Mounting base to secure boiler to concrete base.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

E. Barometric Damper: Galvanized-steel assembly with 3-1/2-inch diameter flue-gas thermometer

2.5 BURNER

A. Burner: Welded construction with multi-vane, stainless-steel, flame-retention diffuser for natural gas. Mount burner on hinged access door to permit access to combustion chamber.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
   1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Gas Train: Control devices and modulating control sequence shall comply with requirements in FMG Pilot: Intermittent electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

D. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.

2.6 BURNER

A. Burner: Welded construction with multi-vane, stainless-steel, flame-retention diffuser for fuel oil. Mount burner on hinged access door to permit access to combustion chamber.
B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Oil Supply: Control devices and modulating control sequence shall comply with requirements FMG

1. Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.
2. Oil Piping Specialties:
   b. Removable-mesh oil strainer.
   c. 0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.
   d. 0- to 300-psig oil-nozzle pressure gage.
   e. Nozzle-line, solenoid-safety-shutoff oil valve.

D. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with UV scanner flame-safety control.

E. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.


2.7 BURNER

A. Burner: Welded construction with multi-vane, stainless-steel, flame-retention diffuser for fuel oil and natural gas. Mount burner on hinged access door to permit access to combustion chamber.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
a. **Motor Sizes:** Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. **Oil Supply:** Control devices and modulating control sequence shall comply with requirements in FMG Oil pump may be remotely mounted and shipped separately. Edit performance parameters in first subparagraph below to suit Project.

1. **Oil Pump:** Two-stage, gear-type oil pump integral to and directly driven by blower shall be capable of producing 300-psig discharge pressure and 15-inch Hg vacuum.
2. **Oil Piping Specialties:**
   b. Removable-mesh oil strainer.
   c. 0- to 30-inch Hg vacuum; 0- to 30-psig vacuum-pressure gage.
   d. 0- to 300-psig oil-nozzle pressure gage.
   e. Nozzle-line, solenoid-safety-shutoff oil valve.

D. **Gas Train:** Control devices and modulating control sequence shall comply with requirements in FMG Gas Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

E. **Oil Pilot:** Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with UV scanner flame-safety control.

F. **Flue-Gas Recirculation:** Burner connections shall be equipped for recirculating flue gas.

1. **Maximum Oxides of Nitrogen Emissions 30 ppm.**

2.8 **TRIM**

A. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9" Building Services Piping.*

B. **Aqua-stat Controllers:** Operating, firing rate, and high limit.

C. **Safety Relief Valve:** ASME rated.

D. **Pressure and Temperature Gage:** Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. **Boiler Air Vent:** Automatic.

G. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.

1. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.9 TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping ANSI B31.9" Building Services Piping."

B. Pressure Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve:

1. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
   a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

D. Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

E. Water Column: Minimum 12-inch glass gage with shutoff cocks.

F. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.

G. Blow-down Valves: Factory-installed bottom and surface, slow-acting blow-down valves same size as boiler nozzle. Blow-down valves shall be combination of slow and quick acting as required by ANSI B31.1.

H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler
nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.

I. Stop-Check Valves: Factory-installed, stop-check valve and stop valve for field installation at boiler outlet with free-blow drain valve for field installation between the two valves and visible when operating stop-check valve.

J. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper manifold and sealed with fiber gasket.

1. Tappings NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. Tappings NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

2.10 CONTROLS

A. Refer to Division 23Section "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feed water pump(s) for makeup water control.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 200 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.
6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.

a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature or pressure.
2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
3. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Management System Interface: Factory-install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:
   a. Monitoring: On/off status, common trouble alarm low water level alarm.
   b. Control: On/off operation, hot water supply temperature set-point adjustment steam pressure adjustment.

2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.11 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 12 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to circuit breaker.
5. Provide branch power circuit to each motor and to controls circuit breaker.
6. Provide each motor with overcurrent protection.
2.12 CAPACITIES AND CHARACTERISTICS

A. Heating Medium: Hot water or Steam.

B. Design Pressure Rating: 30 psig 60 psig 100 psig 125 psig 140 psig 160 psig <Insert value>.

C. Design Pressure Rating: 15 psig 150 psig 200 psig 250 psig 300 psig 350 psig <Insert value>.

D. Safety Relief Valve Setting: <Insert psig.>

E. Entering-Water Temperature: <Insert deg F.>

F. Leaving-Water Temperature: <Insert deg F.>

G. Design Water Flow Rate: <Insert gpm.>

H. Design Pressure Drop: <Insert psig.>

I. Steam Operating Pressure: <Insert psig.>

J. Steam Flow Rate: <Insert lb/h.>

K. Minimum Efficiency (AFUE): <Insert value> percent.

L. Number of Passes: Two Four <Insert number>.

M. AGA Input: <Insert MBh.>

N. I=B=R Input: <Insert MBh.>

O. Gas Input: <Insert cfh.>

P. Oil Input: <Insert gph.>

Q. AGA Output Capacity: <Insert MBh.>

R. DOE Output Capacity: <Insert MBh.>

S. Equivalent Direct Radiation: <Insert EDR.>

T. Tankless Water Heater:
2. Design Pressure Drop: <Insert psig.>
3. Entering-Water Temperature: <Insert deg F.>
4. Leaving-Water Temperature: <Insert deg F.>

U. Burner Blower:
1. Motor Horsepower: <Insert value.>
2. RPM: <Insert value.>

V. Electrical Characteristics:
1. Volts: 115 208 230 460 <Insert value> V.
3. Hertz: 60.
5. Minimum Circuit Ampacity: <Insert value.>

2.13 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

2.14 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
   b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature steam pressure.
   c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
3. Perform field performance tests to determine the capacity and efficiency of boilers.
   a. For dual-fuel boilers, perform tests for each fuel.
   b. Test for full capacity.
   c. Test for boiler efficiency at low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20 <Insert range> percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
BOILER FEEDWATER PUMPS
SECTION 235313 - BOILER FEEDWATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Feed water pumps and receivers.
   2. Vacuum-type feed water pumps and receivers.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Fabricate and test unit according to ASME PTC 12.1, "Closed Feed water Heaters."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: ASME B31.1, "Power Piping," for systems more than 15 psig. ASME B31.9, "Building Services Piping," for systems equal to or less than 15 psig. Safety valves and pressure vessels shall bear the appropriate ASME label.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include rated capacity, temperature and NPSH required, pump performance curves with selection points clearly indicated, and furnished specialties and accessories.

B. Shop Drawings: Include plans, elevations, sections, details, dimensions, weights, loadings, required clearances, method of field assembly, and attachments to other work.

C. Manufacturer Seismic Qualification Certification: Submit certification that feedwater equipment, accessories, and components will withstand seismic forces defined in Division 23.
Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of internal and external parts during a seismic event and the unit will be fully operational after the event."

2. Dimensioned Outline Drawings of Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For feedwater equipment to include in emergency, operation, and maintenance manuals.

F. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:

1. BFS Industries, LLC.
2. Bryan Boilers; Bryan Steam, LLC.
3. Cleaver-Brooks; Div. of Aqua-Chem, Inc.
4. Domestic Pump; a unit of ITT Fluid Technology.
5. Skidmore.

2.1 FEEDWATER UNITS
A. Description: Factory-assembled and -tested unit consisting of a receiver, duplex feedwater pumps, controls, and the following features and accessories:

1. Bimetal dial-type thermometer graduated in Fahrenheit.
2. Level gage glass, reflex flat type, with stops at top and bottom.
3. Lifting eyes.
5. Pump, suction and discharge isolation valve, inlet strainer, discharge check valve, and liquid-filled pressure gage.
7. Feed water Heater: Sparge tube, thermostat, and control valve.
8. Factory-Installed Pipe, NPS 2-1/2 and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40/80; with threaded joints and fittings.
9. Factory-Installed Pipe, NPS 3 and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40/80; with welded joints and carbon-steel fittings and flanges.
   a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
   b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 300, including bolts, nuts, and gaskets.

B. Receiver:

2. Additional corrosion protection:
   a. 0.07-inch thickness allowance.
   b. Electrolytic corrosion-inhibitor anode.
3. Finish: Primer under epoxy topcoat.
5. Mounting Frame: Structural-steel stand to support receiver and pumps. Fabricate stand with bracing adequate for seismic forces according to authorities having jurisdiction and to allow anchoring mounting frame to floor.
C. Vertical Feed water Pump: Flange-mounted, close-coupled, single-stage, multistage, radially split-case-design centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of at least 225 deg F with the following features:

1. Impeller: Bronze.
2. Seals: Mechanical.

D. Horizontal Feed water Pump: Base-mounted, single-stage, multistage, radially split-case-design centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of at least 225 deg F with the following features:

1. Impeller: Bronze.
2. Coupling: Flexible.

E. Control panel shall be unit mounted and factory wired and include the following:

1. NEMA 250, Type 12 enclosure.
2. Single-point field power interface to circuit breaker.
   a. Branch power circuit to each motor and to controls circuit breaker.
3. NEMA-rated motor controller for each motor, and include a hand-off-auto switch and overcurrent protection.
   a. Alternating controls for duplex units with intermittent operation as indicated by control sequence.
4. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
5. Wiring outside of an enclosure in a metal raceway. Make connections to motor with liquid-tight conduit.
6. Removable control mounting plate.
7. Visual indication of status and alarm with momentary test push button.
8. Audible alarm and silence switch.
10. Fused control-circuit transformer.
11. Microprocessor-based controller.

F. Feed water Duplex-Pump Control Sequence:

1. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
2. Lead and lag pumps alternate to equalize run time.
3. Lead pump failure, lag pump automatically starts if lead pump cannot maintain set point.
4. Visual indication of pump on and off status.
5. Visual indication of pump lead/lag status.

G. Receiver Makeup Water Control Sequence:

1. Electric level controller operates electric control valve to maintain receiver water-level set point.
2. Visual and audible alarm indication of low and high receiver-water level.

H. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.

1. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, receiver low-water-level alarm, receiver high-water-level alarm, feedwater temperature.

I. Capacities and Characteristics:

1. Condensate Receiver:

   b. Diameter: <Insert inches.>
   c. Length: <Insert inches.>
   d. Height to Condensate Inlet: <Insert inches.>
   e. Condensate Return Minimum Inlet Size: <Insert NPS.>
   f. Makeup Water Minimum Inlet Size: <Insert NPS.>
   g. Sparge-Tube Steam Supply: <Insert lb/h.>

2. Feed water Pumps:
a. No. of Pumps: Duplex <Insert number>. 
b. Flow Rate: <Insert gpm>. 
c. NPSH Required: <Insert psig>. 
d. Rated Operating Temperature: <Insert deg F>. 
e. Head Pressure: <Insert psig>. 
f. Horsepower: <Insert horsepower>. 
g. Speed: <Insert value> RPM. 
h. Volts: 115 208 230 460 <Insert value> V. 
i. Phase: Single Three. 
j. Hertz: 60.

2.2 FEEDWATER UNIT WITH VACUUM PRODUCER

A. Description: Receiver mounted, consisting of multi-jet vacuum producer, centrifugal pump and motor assembly mounted on separation chamber, and automatic pressure and water temperature controls. Include the following accessories:

1. Bimetal dial-type thermometer graduated in Fahrenheit .
2. Vacuum Gage: Dial-type register in inches of mercury.
3. Level Gage Glass: Stops top and bottom.
5. Lifting eyes.
7. Low-water cutoff switch.
10. Overflow drain from vacuum-producer receiver.
11. Factory-Installed Pipe, NPS 2-1/2 and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 with threaded joints and fittings.

12. Factory-Installed Pipe, NPS 3 and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 with welded joints and carbon-steel fittings and flanges.
   a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 300, including bolts, nuts, and gaskets.

B. Vacuum-Producer Reservoir and Vacuum Receiver:

2. Additional corrosion protection:
   a. 0.07-inch thickness allowance.
   b. Electrolytic corrosion-inhibitor anode.
3. Finish: Primer under epoxy topcoat.
6. Mounting Frame: Structural-steel stand to support receiver and pumps. Fabricate stand with bracing adequate for seismic forces according to authorities having jurisdiction and to allow anchoring mounting frame to floor.

C. Vertical Vacuum-Producer Pump: Flange-mounted, close-coupled, single-stage, radially split-case-design centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of at least 225 deg F; with the following features:

   1. Impeller: Bronze.

D. Horizontal Vacuum-Producer Pump: Base-mounted, single-stage, radially split-case-design centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of at least 225 deg F; with the following features:

   1. Impeller: Bronze.
   4. Seals: Mechanical.
E. Vertical Feed water Pump: Flange-mounted, close-coupled, single-stage, multistage, radially split-case-design centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of at least 225 deg F; with the following features:

1. Impeller: Bronze.
2. Seals: Mechanical.

F. Horizontal Feed water Pump: Base-mounted, single-stage, multistage, radially split-case-design centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of at least 225 deg F; with the following features:

1. Impeller: Bronze.
2. Coupling: Flexible.

G. Control panel shall be unit mounted and factory wired and include the following:

1. Vacuum Switches for Duplex Vacuum-Producer Pumps: Include pressure adjustment, and test push button. Factory set so one pump operates for 3 to 5 inches of mercury and both pumps operate for 4 to 6 inches of mercury.
2. NEMA 250, Type 12 enclosure.
3. Single-point field power interface to circuit breaker.
   a. Branch power circuit to each motor and to controls circuit breaker.
4. NEMA-rated motor controller for each motor and include a hand-off-auto switch and overcurrent protection.
   a. Alternating control for units with intermittent operation as indicated by control sequence.
5. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Removable control mounting plate.
8. Visual indication of status and alarm with momentary test push button.
10. Visual indication of elapsed run time, graduated in hours.
11. Fused control-circuit transformer.

H. Vacuum-Producer Control Sequence:

1. Cycle pumps to maintain vacuum-pressure set point.
2. Visual indication of pump on and off status.

I. Feed water Duplex-Pump Control Sequence:

1. Boiler water-level controller starts and stops lead pump to maintain boiler water-level set point.
2. Lead and lag pumps alternate to equalize run time.
3. Lead pump failure, lag pump automatically starts if lead pump cannot maintain set point.
4. Visual indication of pump on and off status.
5. Visual indication of pump lead/lag status.

J. Makeup Water Control Sequence:

1. Electric level controller operates electric control valve to maintain water temperature set point.
2. Visual and audible alarm indication of low and high water level.

K. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.

1. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, receiver low-water-level alarm, receiver high-water-level alarm, feedwater temperature.

L. Capacities and Characteristics:

1. Vacuum-Producer Reservoir:
   b. Diameter: <Insert inches.>
   c. Length: <Insert inches.>
d. Cooling Makeup Water Supply: <Insert NPS.>

e. Overflow Drain: <Insert NPS.>

2. Vacuum-Producers Pumps:

a. No. of Pumps: Simplex Duplex <Insert number>.
b. Air Capacity: <Insert cfm.>
c. Head Pressure: <Insert inches of mercury.>
d. Horsepower: <Insert horsepower.>
e. Speed: <Insert value> RPM.
f. Volts: 115 208 230 460 <Insert value> V.
g. Phase: Single Three.
h. Hertz: 60.

3. Vacuum Receiver:

b. Diameter: <Insert inches.>
c. Length: <Insert inches.>
d. Height to Condensate Inlet: <Insert inches.>
e. Condensate Return Minimum Inlet Size: <Insert NPS.>

4. Feed water Pumps:

a. No. of Pumps: Simplex Duplex <Insert number>.
b. Flow Rate: <Insert gpm.>
c. NPSH Required: <Insert psig.>
d. Rated Operating Temperature: <Insert deg F.>
e. Head Pressure: <Insert psig.>
f. Horsepower: <Insert horsepower.>
g. Speed: <Insert value> RPM.
h. Volts: 115 208 230 460 <Insert value> V.
i. Phase: Single Three.
j. Hertz: 60.

2.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

   1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with manufacturer’s written instructions.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Check bearing lubrication.
   4. Verify proper motor rotation.
   5. Start-up service.

2.4 REMOVE AND REPLACE MALFUNCTIONING UNITS AND RETEST AS

END OF SECTION 235313
DEAERATORS
PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes packaged, factory-assembled deaerators.

1.2 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   
   B. ASME Compliance: ASME B31.1, "Power Piping," for systems more than 15 psig ASME B31.9, "Building Services Piping," for systems equal to or less than 15 psig. Safety valves and pressure vessels shall bear the appropriate ASME label.

1.3 FACILITY OPERATIONS REQUIREMENTS
   A. Product Data: For each type of product indicated. Include rated makeup water, feedwater, and steam flow rates; working pressure; tank capacities; storage capacity in minutes; temperature and NPSH required; pump performance curves with selection points clearly indicated; furnished specialties; and accessories.
   
   B. Shop Drawings: For deaerators, signed and sealed by a qualified professional engineer; include plans, elevations, sections, details, dimensions, weights, loadings, required clearances, and attachments to other work.
      1. For installed products indicated to comply with design loads, include structural analysis data.
      2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing deaerator bases.
   
   C. Manufacturer Seismic Qualification Certification: Submit certification that deaerators, accessories, and components will withstand seismic forces as indicated in Division 23
Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For deaerators to include in emergency, operation, and maintenance manuals.

F. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS:
   THE FOLLOWING ARE BASE BID MANUFACTURERS:

   1. BFS Industries, LLC.
   2. Bryan Boilers; Bryan Steam, LLC.
   3. Cleaver-Brooks; Div. of Aqua-Chem, Inc.
   4. Domestic Pump; a unit of ITT Fluid Technology
   5. Skidmore

2.2 MANUFACTURED UNITS

A. Horizontal packed-column, spray single-compartment deaerator, and a separate packaged surge tank with transfer and feedwater pumps and controls to supply feedwater to deaerator.
B. Material for Wetted Components: Components in contact with water that has not been deaerated shall be made of Type 304 stainless steel.

C. Adjustable Spray Valves: Type 316 stainless steel. Arrange spray valves for counterflow of steam and condensate and so corrosive gases being vented do not contact deaerator’s head or shell.

D. Vent Condenser: Stainless steel, with automatic and manual vent valves.

E. Deaerator and Storage Tank:

2. Additional Corrosion Protection:
   a. 0.07-inch thickness allowance.
   b. Electrolytic corrosion-inhibitor anode.

3. Access: Manhole in deaerator and storage tank for access to internal components for inspection and service.
5. Factory-Installed Pipe, NPS 2-1/2 and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 80; with threaded joints and fittings.
   b. Forged-Steel Fittings: ASME B16.11, Class 3000.
   d. Forged-Steel Unions: MSS SP-83, Class 3000.

6. Factory-Installed Pipe, NPS 3 and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 80; with welded joints and carbon-steel fittings and flanges.
   a. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
   b. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 300, including bolts, nuts, and gaskets.

F. Accessories:

1. Lifting eyes.
2. Companion flanges.
3. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.

4. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in pounds force per square inch.

5. Pump-discharge bypass relief valve with orifice plate.

6. Makeup Water Assembly:
   a. Factory mounted, electric, modulating valve with factory-mounted, probe-type water-level controller.
   b. Factory-mounted, three-valve bypass and inlet strainer.

7. Steam Pressure-Reducing Valve(s): Steam operated with three-valve bypass, and sized to reduce boiler outlet pressure to the deaerator design pressure.

8. Tank Overflow Drain: Sized to relieve full capacity at operating pressure.

9. Safety Valve(s): ASME labeled and sized to relieve full capacity of pressure-reducing valve.


11. Vacuum breaker.

12. Meters and Gages:
   a. Full-height, water-level gage glass, reflex flat type, and stop valve set.
   b. Bimetal dial-type thermometer graduated in Fahrenheit mounted to measure temperature in storage and steam section of tank.
   c. Pressure gage graduated in pounds force per square inch mounted to measure pressure in steam section of tank.

13. Chemical injection quill.


15. Tank drain connection with valve.


G. Support Frame: Structural-steel frame for supporting tank and pumps. Weld or bolt to tank.

1. Fabricate support frame with bracing adequate for seismic forces according to authorities having jurisdiction and to allow installation by anchoring deaerators to floor only.

H. Feedwater Pump: Cast-iron base-mounted volute; with bronze multistage centrifugal impeller, renewable bronze case ring, and stainless-steel shaft.

1. Seals: Mechanical, suitable for 250 deg F.
2. Pump Motor: Horizontal, totally enclosed fan-cooled enclosure, flexible coupled to pump. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

I. Feedwater Pump Control Panel: Factory mounted and wired and including the following:

1. NEMA 250, Type 12 enclosure.
2. Single-point, field power connection to circuit breaker.
   a. Branch power circuit to each motor and to controls circuit breaker.
3. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor.
   a. Alternating control as indicated by control sequence for each pump.
4. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
5. Metal raceway for factory-installed wiring outside of enclosures. Make connections to motor with liquid-tight conduit.
6. Removable control mounting plate.
7. Visual indication of status and alarm with momentary test push button.
8. Audible alarm and silence switch.
10. Fusible, control-circuit transformer.
11. Microprocessor-based controller.

J. Feedwater Pump Continuous Control Sequence:

1. Pump runs continuously while boiler operates. Electric interlock with boiler control starts lead pump when boiler starts.
2. Boiler water-level controller modulates feedwater control valve to maintain boiler water-level set point. Valve closes when boiler is off.
3. Lead and lag pumps alternate to equalize run time.
4. Lead pump failure automatically starts lag pump.
5. Visual indication of pump on and off status.

K. Makeup Water Control Sequence:
1. Electric level controller operates electric control valve to maintain tank water-level set point.
2. Visual and audible alarm indication of low and high tank water level.

1. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.

1. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, low-water level alarm, high-water level alarm, feedwater temperature.

2.3 SURGE TANK

A. Description: Factory-assembled and -tested unit consisting of a condensate receiver, transfer pumps, and controls.

B. Accessories:

1. Bimetal dial-type thermometer graduated in Fahrenheit
2. Level gage glass, reflex flat type, with stops at top and bottom.
3. Lifting eyes.
5. Pump suction piping with vortex breaker, isolation valve, strainer, and flexible connector.
6. Pump discharge piping with check valve, isolation valve, and liquid-filled pressure gage graduated in pounds force per square inch.
7. Pump-discharge bypass relief valve with orifice plate.

C. Factory-Installed Pipe, NPS 2-1/2 and Smaller: ASTM A 53/A 53M, Type S (seamless), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40; with threaded joints and following fittings:


D. Factory-Installed Pipe, NPS 3 and Larger: ASTM A 53/A 53M, Type E (electric-resistance welded), Grade B; or ASTM A 106, Type S, Grade B, Schedule 40 with welded joints and carbon-steel fittings and flanges.

1. Wrought-Steel Fittings: ASME B16.9, wall thickness to match adjoining pipe.
2. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, Class 300, including bolts, nuts, and gaskets.
E. Tank:

2. Additional Corrosion Protection:
   a. 0.07-inch thickness allowance.
   b. Electrolytic corrosion-inhibitor anode.
3. Access: Manhole in tank for access to internal components for inspection and service.

F. Support Frame: Structural-steel frame for supporting tank. Weld or bolt to tank.

1. Fabricate support frame with bracing adequate for seismic forces according to authorities having jurisdiction and to allow installation by anchoring deaerators to floor only.

G. Transfer Pump: Vertical, flange-mounted, close-coupled, single-stage radially split-case centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F (with the following features:

1. Impeller: Bronze
2. Seals: Mechanical.

H. Transfer Pump: Horizontal, base-mounted, single-stage radially split-case centrifugal pump; rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F with the following features:

1. Impeller: Bronze
2. Coupling: Flexible.

I. Transfer Pump Control Panel: Factory mounted and wired and including the following:

1. NEMA 250, Type 12 enclosure.
2. Single-point, field power connection to circuit breaker.
   a. Branch power circuit to each motor and to controls circuit breaker.
3. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor.
   a. Alternating control indicated by control sequence for each pump.
4. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
5. Metal raceway for factory-installed wiring outside of enclosures. Make connections to motor with liquid-tight conduit.
6. Removable control mounting plate.
7. Visual indication of on/off status and pump failure alarm with momentary test push button.
8. Audible alarm and silence switch.
10. Fusible, control-circuit transformer.
11. Microprocessor-based controller.

J. Transfer Pump Start-Stop Control Sequence: Deaerator water-level controller controls lead pump; alternator switches lead and lag pump to equalize run time; failure of lead pump switches to lag pump and sounds audible alarm.

K. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points.
1. Hardwired Monitoring Points: On/off status for each pump, failure alarm for each pump, low-water level alarm, high-water level alarm.

2.4 CAPACITIES AND CHARACTERISTICS

A. Feedwater Flow Rate: <Insert gpm

B. Steam Flow Rate: <Insert lb/h

C. Makeup Water Flow Rate: <Insert gpm

D. Makeup Water Temperature: <Insert deg F
Deaerators

E. Capacity: Capable of raising temperature of condensate and makeup water to within 3 deg F of saturated steam temperature.

F. Minimum Working Pressure: 50 psig

G. Operating Pressure Range: Atmospheric to From 2 to 15 psig.

H. Resultant Oxygen Content: Not more than 0.03 cc/L through an operating range between 5 and 100 percent of full load.

I. Storage Tank:
   1. Tank Capacity to Overflow: <Insert gal.>
   2. Storage Time: 10 <Insert number> minutes.

J. Feedwater Pumps:
   1. No. of Pumps: Duplex <Insert quantity>.
   2. Flow Rate: <Insert gpm
   3. NPSH Required: <Insert psig
   4. Rated Operating Temperature: <Insert deg F
   5. Head Pressure: <Insert psig
   6. Horsepower: <Insert hp
   7. Speed: <Insert rpm.>
   8. Volts: 115 208 230 460 <Insert value> V.

K. Surge Tank:
   1. Tank Capacity to Overflow: <Insert gal.>
   2. Storage Time: <Insert number> minutes.

L. Transfer Pumps:
   1. No. of Pumps: Duplex <Insert quantity>.
   2. Flow Rate: <Insert gpm
   3. NPSH Required: <Insert psig
   4. Rated Operating Temperature: <Insert deg F
   5. Head Pressure: <Insert psig
   6. Horsepower: <Insert hp

7. Speed: <Insert rpm.>
8. Volts: 115 208 230 460 <Insert value> V.

2.5 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.
B. Manufacturer's standard paint in standard colors, applied to factory-assembled and -tested unit before shipping.
C. Do not paint aluminum, galvanized-steel, and stainless-steel surfaces.

2.6 SOURCE QUALITY CONTROL

A. Fabricate and label deaerator tanks according to ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
B. Factory install and test piping that connects pumps to tanks according to ASME B31.1, "Power Piping ASME B31.9, "Building Services Piping."

2.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
B. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
C. Tests and Inspections:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections, for compliance with requirements.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Verify bearing lubrication.
4. Verify proper motor rotation.
5. Test Reports: Prepare a written report to record the following:
   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning equipment and retest as specified above.

END OF SECTION 235316
HEAT EXCHANGERS FOR HVAC
SECTION 235700 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes shell-and-tube and plate heat exchangers.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."

B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

C. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.

2. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Manufacturer Seismic Qualification Certification: Submit certification that heat exchanger, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

E. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:

   1. Armstrong Pumps, Inc.
   2. Alfa Laval Inc.
   3. ITT Industries; Bell & Gossett.
   4. Taco, Inc
   5. Sondex

2.2 SHELL-AND-TUBE HEAT EXCHANGERS

A. Configuration: U-tube with removable bundle.

B. Shell Materials: Steel.

C. Head:

   1. Materials: Cast iron.
   2. Flanged and bolted to shell.
D. Tube:
   1. Seamless copper tubes.
   2. Tube diameter is determined by manufacturer based on service.

E. Tube-sheet Materials: Steel tube-sheets.

F. Baffles: Steel.

G. Piping Connections:
   1. Shell: Flanged inlet and outlet fluid connections, threaded drain, and vent connections.
   2. Head: Flanged inlet and outlet fluid connections.

H. Support Saddles:
   1. Fabricated of material similar to shell.
   2. Foot-mounted with provision for anchoring to support.
   3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

I. Capacity and Characteristics:
   1. General:
      a. Shell Diameter, NPS: <Insert size.>
      c. Heat-Exchanger Surface Area, sq. ft.: <Insert measurement.>
      d. Number of Passes: <Insert number.>
      e. Heat Exchanged, Btu/h: <Insert capacity.>
      f. Operating Weight, lb: <Insert weight.>

   2. Tube Side:
      b. Fluid Specific Heat: <Insert value.>
      c. Fluid Specific Gravity: <Insert value.>
      d. Working Pressure, psig: <Insert value.>
      e. Supply Pressure, psig: <Insert value.>
      f. Flow Rate, lbs/hr. or gpm: <Insert value.>
g. Pressure Drop, psig: <Insert value.>

h. Inlet Temperature, Deg F: <Insert temperature.>

i. Outlet Temperature, Deg F: <Insert temperature.>

j. Fouling Factor: <Insert value.>

k. Inlet Size, NPS: <Insert size.>

l. Outlet Size, NPS: <Insert size.>

3. Shell Side:


b. Fluid Specific Heat: <Insert value.>

c. Fluid Specific Gravity: <Insert value.>

d. Working Pressure, psig: <Insert value.>

e. Supply Pressure, psig: <Insert value.>

f. Flow Rate, lb/h gpm: <Insert value.>

g. Pressure Drop, psig: <Insert value.>

h. Inlet Temperature, Deg F: <Insert temperature.>

i. Outlet Temperature, Deg F: <Insert temperature.>

j. Fouling Factor: <Insert value.>

k. Inlet Size, NPS: <Insert size.>

l. Outlet Size, NPS: <Insert size.>

2.3 GASKETED PLATE HEAT EXCHANGERS

A. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

B. Frame:

1. Capacity to accommodate 20 percent additional plates.

2. Painted carbon steel with provisions for anchoring to support.

C. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger carrying and guide bars are anchored to building structure.
Heat Exchangers for HVAC

D. End-Plate Material: Painted carbon steel.

E. Tie Rods and Nuts: Steel or stainless steel.

F. Plate Material: 0.031 inch thick before stamping; Type 304 stainless steel.

G. Gasket Material: EPDM.

H. Piping Connections:
   1. End plate with welded carbon-steel nozzles. Threaded pipe connection for NPS 2 and smaller; carbon-steel flanged pipe connection for larger sizes.

I. Enclose plates in a solid stainless-steel removable shroud.

J. Capacity and Characteristics:
   1. General:
      a. Heat-Exchanger Surface Area, sq. ft.: <Insert measurement.>
      b. Number of Plates: <Insert number.>
      c. Number of Passes: One <Insert number.>
      d. Heat Exchanged, Btu/h: <Insert capacity.>
      e. Operating Weight, lb: <Insert weight.>

   2. Hot Side:
      b. Fluid Specific Heat: <Insert value.>
      c. Fluid Specific Gravity: <Insert value.>
      d. Working Pressure, psig: <Insert value.>
      e. Supply Pressure, psig: <Insert value.>
      f. Flow Rate, lbs/hr. or gpm: <Insert value.>
      g. Pressure Drop, psig: <Insert value.>
      h. Inlet Temperature, Deg F: <Insert temperature.>
      i. Outlet Temperature, Deg F: <Insert temperature.>
      j. Fouling Factor: <Insert value.>
      k. Inlet Size, NPS: <Insert size.>
      l. Outlet Size, NPS: <Insert size.>

   3. Cold Side:
b. Fluid Specific Heat: <Insert value.>
c. Fluid Specific Gravity: <Insert value.>
d. Working Pressure, psig: <Insert value.>
e. Supply Pressure, psig: <Insert value.>
f. Flow Rate, lb/h or gpm: <Insert value.>
g. Pressure Drop, psig: <Insert value.>
h. Inlet Temperature, Deg F: <Insert temperature.>
i. Outlet Temperature, Deg F: <Insert temperature.>
j. Fouling Factor: <Insert value.>
k. Inlet Size, NPS: <Insert size.>
l. Outlet Size, NPS: <Insert size.>

2.4 BRAZED PLATE HEAT EXCHANGERS

A. Configuration: Brazed assembly consisting of two end plates, one with threaded nozzles and pattern-embossed plates.

B. End-Plate Material: Type 316 stainless steel.

C. Threaded Nozzles: Type 316 stainless steel.

D. Plate Material: Type 316 stainless steel.

E. Brazing Material: Copper.

F. Capacity and Characteristics:

1. General:
   a. Heat-Exchanger Surface Area, sq. ft.: <Insert measurement.>
   b. Heat Exchanged, Btu/h. <Insert capacity.>
   c. Operating Weight, lb: <Insert weight.>

2. Hot Side:
   b. Fluid Specific Heat: <Insert value.>
   c. Fluid Specific Gravity: <Insert value.>
   d. Working Pressure, psig: <Insert value.>
e. Supply Pressure, psig: <Insert value.>
f. Flow Rate, lbs/hr. or gpm: <Insert value.>
g. Pressure Drop, psig: <Insert value.>
h. Inlet Temperature, Deg F: <Insert temperature.>
i. Outlet Temperature, Deg F: <Insert temperature.>
j. Fouling Factor: <Insert value.>
k. Inlet Size, NPS: <Insert size.>
l. Outlet Size, NPS: <Insert size.>

3. Cold Side:

   b. Fluid Specific Heat: <Insert value.>
   c. Fluid Specific Gravity: <Insert value.>
   d. Working Pressure, psig: <Insert value.>
   e. Supply Pressure, psig: <Insert value.>
   f. Flow Rate, lbs/hr. or gpm: <Insert value.>
   g. Pressure Drop, psig: <Insert value.>
   h. Inlet Temperature, Deg F: <Insert temperature.>
   i. Outlet Temperature, Deg F: <Insert temperature.>
   j. Fouling Factor: <Insert value.>
   k. Inlet Size, NPS: <Insert size.>
   l. Outlet Size, NPS: <Insert size.>

2.5 FIELD QUALITY CONTROL

   A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 235700
SENI 235710 – STEAM GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Perform all Work required to provide and install unfired steam generators with the required trim components and all related appurtenances to make a complete, functioning and operational system that will supply process steam or stainless steel constructed unit to provide clean steam for humidification, sterilizer and pharmaceutical equipment.

1. Process Steam Generator, Steam to Steam using Soft Water.

2. Clean Steam Generator, Steam-to-Steam using Reverse Osmosis (RO) or Deionized (DI) Water.

1.2 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within all references.

1.3 QUALITY ASSURANCE

A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section VIII, Division 1 for design and fabrication of pressure vessels for manufacture of tubular heat exchangers and heat exchanger shells.

B. Factory testing of the steam heat exchanger units shall be in strict conformance with all applicable sections of the ASME code and shall bear the applicable ASME symbol and stamps.

C. All equipment or components of this Section shall meet or exceed the requirements and quality of items specified and as indicated on the Drawings.

D. Ensure that equipment pressure ratings are at least equal to system’s maximum operating pressure at point where installed, but not less than specified.
E. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of five (5) years experience.

F. Ensure pump operation at specified system fluid temperatures without vapor binding and cavitation, is non-overloading when the pump is operating in parallel or individual operation.

G. Where applicable, the manufacturer shall be listed by Underwriter’s Laboratories as a manufacturer of packaged pumping systems.

1.4 SUBMITTALS

A. Product Data:

1. Submit product data including certified rated capacities, performance curves of selected model, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate the feedwater pump’s operating point on volume flow and head pressure curves.

NOTE TO ENGINEER: CLEAN STEAM GENERATORS FOR STERILIZATION AND HUMIDIFICATION NORMALLY DO NOT REQUIRED FEED WATER PUMPS. IF THERE IS LESS THAN A 15 POUNDS PRESSURE DIFFERENTIAL, A SEPERATE FEEDWATER PUMP MUST BE PROVIDED IN THE DESIGN OF THE MAKE-UP WATER SYSTEM TO THE BOILER.

2. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

B. Seismic Qualification Certificates: For heat exchanger, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether seismic certification is based on actual test of assembled components or on calculation.

2. If seismic certification is based on calculation, manufacturer shall keep it as a record within its on quality assurance requirements and or submit a copy of the seismic calculation to the Owner.

C. Record Documents:

1. Submit Shop Drawings and product data, including footprint dimensions, pipe sizes, pipe descriptions, pipe arrangement, and electrical and control panel Drawings.

2. Submit dimensioned floor plan Drawings with all related system piping, equipment piping and support locations.
3. Submit manufacturer’s installation instructions.

4. Submit pressure test reports of vessel shell and tube bundle pressure tests.

D. Operation and Maintenance Data:

1. At project closeout, submit operation and maintenance data that includes start-up and shut down instructions, assembly Drawings, a spare and replacement parts lists.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under provisions of Division 01 and Division 20.

B. Protect internals from entry of foreign material by temporary caps on flanged openings.

1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace failed components, materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including heat exchanger, storage tank, and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MANUFACTURERS

A. Spriax Sarco

B. Reco

C. Armstorng
2.3 UNFired steam generators – steam to steam

A. Unfired steam generators shall be furnished as a complete package ready for installation including all necessary components for operation. The unfired steam generator, steam to steam type, shall be of the sizes and capacities noted on the Drawings. The generator shall consist of specified materials and components and shall be specifically designed for working pressure scheduled. The unfired steam generator selection shall be provided with the scheduled minimum heat transfer surface area required to meet the scheduled capacity and pressure drops. The unfired steam generator shall be factory mounted, wired, piped, and tested.

B. Unfired steam generators shall be ASME Code constructed and stamped in accordance with Section VIII, Division 1, for Unfired Steam Generators and shall be U.L. listed. Generators shall be registered with the National Board of Boiler and Pressure Vessel Inspectors, and a signed copy of the shop inspection report shall be furnished to the Owner. When generating steam above 50 psi, generator welds shall be 100 percent x-rayed in accordance with Section VIII “Unfired Steam Generators” and shall bear the “UB” stamp. When generating steam below 50 psi, generators shall be in accordance with Section VIII “Unfired Steam Generators” and shall bear the “UB” stamp.

C. Mount on a suitable I-Beam support skid, which shall be permanently welded to the shell.

D. Insulation shall be a minimum of 2 inches of fiberglass insulation, protected by not less than a 20 gage thick enamel painted steel jacket.

E. Furnish with materials appropriate for the generated steam fluids noted on the Drawings.

1. Process Generated Steam Fluid– Potable Water (Soft water of less than 8 grains of hardness):
   a. Construct of a carbon steel shell with NPT or flanged carbon steel supply connection.
   b. Furnish with submerged u-tube type heat exchanger coil. On generators where the source steam pressure exceeds 80 psig, 18 gage 90/10 cupro-nickel tubes shall be provided on the coil. Where the source steam pressure is less than 80 psig, 20 gage copper tubes shall be provided on the coil. Tubes shall be expanded into a tubesheet of the appropriate tubesheet material for the tubing being used. Tubes shall be arranged in the tubesheet in a two-pass arrangement with a triangular pitch.
c. All components subject to the generated steam side shall be of copper or carbon steel construction. Component piping on generated steam side shall be carbon steel or copper.

d. Furnish with a vessel steam gauge and pressure to monitor the generated steam. Gauge shall be of copper or brass construction with a steel case and shall be of the appropriate range for the generated steam pressure.

e. Furnish with a carbon steel float type level controller with a steel water column and gauge glass assembly.

f. Furnish with an ASME Code Section I brass pressure relief valve with a capacity to relief the total BTU output of the generator. The valve body shall a ASME “UV” stamp

g. Furnish with a vacuum breaker.

h. Blowdown components shall be of carbon steel construction. Blowdown piping on generated steam side shall be carbon steel.

i. Unfired steam generators operating at 15 psi or below shall be furnished with a brass feed water solenoid valve (factory wired to level control), carbon steel check valve, and high limit solenoid valve. Unfired steam generators operating above 15 psi shall be additionally furnished with a multistage feed water pump sized to generate adequate feedwater pressure for the scheduled generated steam pressure and capacity. Pump shall be factory supplied with a starter wired to the level control. The pump shall discharge into a brass ball valve, brass feed water solenoid valve (factory wired to level control), carbon steel check valve, and high limit solenoid valve.

j. On systems where source fluid water hardness is higher than 10 grains of hardness a water softener shall be provided to soften water to less than 8 grains of hardness to minimize scaling on the unit.

2. Generated Clean Steam Fluid– DI or RO Water :

a. Construct of Type 316L stainless steel shell with NPT or flanged stainless steel supply connection.
b. Furnish with submerged u-tube type heat exchanger coil. On generators where the source steam pressure exceeds 80 psig, 18 gage Type 316L stainless steel tubes shall be provided on the coil. Where the source steam pressure is less than 80 psig, 20 gage stainless steel shall be provided on the coil. Tubes shall be expanded into a Type 316L stainless steel tubesheet.

c. Components subject to the generated steam side shall be Type 316L stainless steel construction. Component piping on generated steam side shall be stainless steel.

d. Furnish with a vessel steam gauge and pressure transmitter to monitor the generated steam. Gauge shall be of stainless steel construction with a stainless steel case and shall be of the appropriate range for the generated steam pressure.

e. Furnish with a stainless steel float type level controller with Type 316L stainless steel water column.

f. Furnish with an ASME Code Section I stainless steel pressure relief valve with a capacity to relief the total BTU output of the generator.

g. Furnish with a vacuum breaker.

h. Blowdown components shall be of stainless steel construction. Blowdown piping on generated steam side shall be stainless steel up to the condensate cooler.

i. Unfired steam generators operating at 15 psi or below shall be furnished with a stainless steel feed water solenoid valve (factory wired to level control), stainless steel check valve, and high limit solenoid valve. Unfired steam generators operating above 15 psi shall be additionally furnished with a multistage feed water pump (with stainless steel wetted components) sized to generate adequate feedwater pressure for the scheduled generated steam pressure and capacity. Pump shall be factory supplied with a starter wired to the level control. The pump shall discharge into a stainless steel ball valve, stainless steel feed water solenoid valve (factory wired to level control), stainless steel check valve, and high limit solenoid valve.

F. All unfired steam generator components subject to the source steam side shall be of copper or carbon steel construction. Component piping on source steam side shall be carbon steel or copper.
G. Furnish with a source steam gauge to monitor the source steam pressure. Gauge shall be of copper or brass construction with a steel case and shall be of the appropriate range for the source steam pressure.

H. Furnish with a pilot actuated control valve to modulate incoming steam to maintain desired output of steam pressure +/- 2 psi. Control valve shall be suitable for 150 psi at 300 degrees F. Control valve pilot pressure transmitter shall monitor output steam pressure and modulate the boiler steam to maintain constant output pressure.

I. Factory supply with dual float and thermostatic traps, one for the coil and one for the drip before the control valve. Provide an incoming steam strainer.

J. Furnished with an internal steam separator.

K. Factory furnish with a high water shut-off. High water shut-off shall include an electronic probe mounted in the top of the unit connected to an electric operated power to open spring to close ball valve for boiler operating at or below 15 psi. For boilers operating above 15 psi steam, high water shut-off shall open the feed water pump circuit. In the event of high water, the ball valve will close.

L. Provide with dry contacts to alert the building automation system (BAS) of either a high pressure, low water, or high water condition occurs. Additionally, the unit shall be provided with a 120-volt alarm bell that is factory wired to sound at any of these conditions. Furnish with an alarm-silencing relay with red alarm light and manual push button.

M. Furnish with a relay for remote on-off control from the BAS system.

N. Furnish with a TDS Blow Down system. A factory installed time sample feed water blow down system consisting of a control, which measures the total dissolved solids in the generator. The blow down operates on a timed basis and if the total dissolved solids exceed the set point, the valve shall blow down the boiler until fresh water brings the total dissolved solids level to the desired setting. Automatic blow off system shall be furnished with a NEMA I control system and be factory wired to a single point 120 volt connection. Field piping of cold water to the unit’s mixing valve and venting from the unit shall be the responsibility of the Contractor.

O. Factory furnish with a factory-mounted blow down \ condensate cooler, ASME code constructed, and stamped for 150 psi working pressure.
P. Minimum steel thickness is 3/16 inches. The blow down enters the tangential inlet where it meets a 90 degree stainless steel wear plate. The wear plate will prevent erosion of the sidewall of the vessel. The tangential blow down entry causes the blow down to swirl around the circumference of the vessel where part of the liquid will flash to steam and the balance will settle to the bottom. The internal flash will go through the vent to atmosphere and the hot condensate and sludge will fall to the bottom of the vessel where it will flow by gravity to the drain leg. The temperature of the condensate will activate the thermal control valve, which will feed cold water into the drain leg where the cold water and hot condensate will mix. This results in drained liquid temperature less than 140 degrees F which is acceptable for municipal sewage. A thermometer is furnished in the drain leg and a check valve is furnished on the coldwater inlet. Tank shall be mounted and piped as part of the Unfired Steam Generator package.

Q. Furnish as factory packages with all wiring to single terminal strip and factory pipe for field connections to city water, source steam, source steam condensate, clean steam outlet, drain, and relief valve outlets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install to permit removal of steam tube bundle with minimum disturbance to installed equipment and piping.

D. Pitch shell to completely drain condensate.

E. Pipe drain valves to nearest floor drain.

F. Install dielectric fittings where ferrous metal and non-ferrous metal are in contact.

G. Proper access space around a device should be planned for servicing the component. Provide no less than the minimum recommended by the manufacturer.

H. Provide an adequate number of isolation valves for service and maintenance of the system and its components.
I. Provide temperature and pressure gauges where shown on Drawings and as directed by Owner.

J. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

K. On condensate coolers that require cooling water for condensate temperature reduction, provide cooling water supply piping and connections as required. Piping should be of adequate size to pass required flow rate.

L. On components that require draining, route piping to appropriate drains for discharge.

M. On components that require venting, provide vent piping from equipment vent connections and pipe to appropriate discharge location.

3.2 TESTING

A. Proper component start-up practices and procedures shall be followed on all components. Provide no less than the minimum as recommended by the manufacturer.

B. Equipment provider shall be responsible for providing certified equipment Start-up.

1. New equipment Start-up shall be for the purpose of determining equipment operation, voltage, and amperage readings.

2. Confirm all proper electrical connections, pump’s balance, discharge and suction gauge readings, and adjustment of head, if required.

C. Provide Start-up reports outlining factory provided Start-up and equipment performance.

3.3 TRAINING

A. Manufacturer’s representative shall instruct Owner’s personnel in the care of the equipment by conducting training session(s).
PACKAGED COMPRESSOR AND CONDENSER UNITS
SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes air- and water-cooled condensing units.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of condensing units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

   1. Units shall be designed to operate with HCFC-free refrigerants.

D. ASME Compliance: Fabricate and label water-cooled condensing units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each condensing unit, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

   1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.


C. Manufacturer Seismic Qualification Certification: Submit certification that condensing units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For condensing units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

G. LEED Submittals:

1. Credit EA 4: Manufacturers’ product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:

1. Carrier Corporation; Carrier Air Conditioning Div.
2. York International Corp.
2.2 CONDENSING UNITS, AIR COOLED, 1 TO 5 TONS

A. Description: Factory assembled and tested, consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

B. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.

1. Motor: Single speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
3. Refrigerant Charge: R-407C or R-410A.

C. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid sub-cooler, with removable drain pan and brass service valves with service ports.

D. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings.

E. Accessories:

1. Coastal Filter: Mesh screen to protect condenser coil from salt damage.
2. Crankcase heater.
3. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
4. Electronic programmable thermostat Low-voltage thermostat and sub-base to control condensing unit and evaporator fan.
5. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
7. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
8. Liquid-line solenoid.
9. Low Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F with time-delay relay to bypass low-pressure switch.
10. Low Ambient Controller: Controls condenser fan speed to permit operation down to minus 20 deg F with time-delay relay to bypass low-pressure switch.
11. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
12. PE mounting base to provide a permanent foundation.
13. Pre-charged and insulated suction and liquid tubing.
15. Thermostatic expansion valve.
16. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.

F. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.3 CONDENSING UNITS, AIR COOLED, 6 TO 120 TONS

A. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

B. Compressor: Hermetic or semi-hermetic compressor designed for service with crankcase sight glass, crankcase heater, and back-seating service access valves on suction and discharge ports.
   2. Refrigerant Charge: - R-407C or R-410A or HFC-134a -

C. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including sub-cooling circuit and back seating liquid-line service access valve. Pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

D. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:
   1. Permanently lubricated ball-bearing motors.
   2. Separate motor for each fan.
   3. Dynamically and statically balanced fan assemblies.

E. Operating and safety controls include the following:
   1. Manual-reset, high-pressure cutout switches.
   2. Automatic-reset, low-pressure cutout switches.
   3. Low oil pressure cutout switch.
   4. Compressor-winding thermostat cutout switch.
   5. Three-leg, compressor-overload protection.
   6. Control transformer.
   7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

F. Accessories:

1. Electronic programmable thermostat Low-voltage thermostat and sub-base to control condensing unit and evaporator fan.
2. Low Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F with time-delay relay to bypass low-pressure switch.
5. Part-winding-start timing relay, circuit breakers, and contactors.

G. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Non-fused disconnect switch, factory mounted and wired, for single external electrical power connection.
5. Condenser coil hail guard grille to protect coil from physical damage.

2.4 CONDENSING UNITS, WATER COOLED

A. Description: Factory assembled and tested, water cooled; consisting of compressors, water-cooled condensers, bases, and unit controls.

B. Compressor: Hermetic or serviceable hermetic type; with oil pump, operating oil charge, and suction and discharge shutoff valves. Factory mounted on base using spring isolators. Include the following:

1. Thermally protected compressor motor.
2. Crankcase heater.
3. Capacity control using cylinder unloading, suction pressure controlled and discharge pressure operated, designed for unloaded start.
4. Refrigerant Charge: R-407C or R-410A or HFC-134a.
C. Condenser: Multi-pass, shell-and-tube type; with replaceable, seamless, integral-finned copper tubes; positive-liquid sub-cooling circuit; pressure relief device; liquid-level test cock; purge connection; liquid-line shutoff valve; and angle valve for connection of water-regulating valve.

1. Unit Construction: ASME stamped for refrigerant-side working pressure of 385 psig and water-side working pressure of 250 psig.

D. Accessories include the following:

1. Discharge-line muffler.
2. Gage panel containing gages for suction, discharge, and oil pressure.
3. Electric solenoid cylinder unloaders.
5. Crankcase cover plates with equalizer connections.

E. Controls: Factory-mounted and -wired panel with the following:

1. Timer to prevent short cycling.
2. High- and low-refrigerant-pressure safety controls.
4. Compressor motor starter.
5. Control-circuit on-off switch.
6. Control-circuit fuse.

2.5 MOTORS

A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
2.6 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate condensing units according to ARI 210/240 ASHRAE/IESNA 90.1 establishes minimum coefficient of performance for air- and water-cooled units smaller than 65,000 Btu/h (19,050 W) and for air- and water-cooled units 65,000 Btu/h (19,050 W) and larger. LEED Prerequisite EA 2 requires minimum efficiency equal to requirements of ASHRAE/IESNA 90.1. LEED Credit EA 1 requires efficiency in excess of minimum efficiency required by ASHRAE/IESNA 90.1.


B. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

2.7 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

C. Remove and replace malfunctioning condensing units and retest as specified above.

END OF SECTION 236200
AIR-COOLED REFRIGERANT CONDENSERS
SECTION 236313 - AIR-COOLED REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, air-cooled condensers for outdoor installation.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-cooled condensers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each air-cooled condenser, include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Manufacturer Seismic Qualification Certification: Submit certification that air-cooled condensers, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
NEW YORK PRESBYTERIAN HOSPITAL
ENGINEERING DESIGN STANDARDS
MARCH, 2015

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For air-cooled condensers to include in emergency, operation, and maintenance manuals.

E. Warranty

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. The following are base bid manufacturers:

1. Bohn Refrigeration Products; Heatcraft, Inc.
2. Carrier Corporation; Carrier Air Conditioning Div.
3. Trane Co. (The); Worldwide Applied Systems Group.
4. York International Corp.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.

B. Condenser Coil: Seamless copper-tube, finned coil; factory tested at 425 psig.

1. Coil Fin: Aluminum
2. Coil Coating: Epoxy
3. Circuit: To match compressors with liquid sub-cooling coil.
4. Refrigerant Accessories: Provide receiver, pressure control, and solenoid valve for each circuit.

C. Condenser Fans and Drives: Propeller fans with aluminum or galvanized-steel fan blades, for vertical horizontal air discharge; directly-driven with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.
D. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 115-V control transformer, if required; magnetic contactors for condenser fan motors and a non-fused factory-mounted and wired disconnect switch for single external electrical power connection.

E. Unit Casings: Galvanized or zinc-coated steel treated and finished with manufacturer’s standard paint coating designed for outdoor installation with weather protection for components and controls, and with the following:

1. Removable panels for access to controls, condenser fans, motors, and drives.
2. Plated-steel fan guards.
3. Lifting eyes.
4. Removable legs.

2.3 MOTORS

A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate air-cooled condensers according to ARI 210/240 Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

2.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer’s starting checklist.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Verify proper airflow over coils.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

C. Remove and replace malfunctioning air-cooled condensers and retest as specified above.

END OF SECTION 236313
EVAPORATIVE REFRIGERANT CONDENSERS
SECTION 236333 - EVAPORATIVE REFRIGERANT CONDENSERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes factory-assembled and -tested, induced or forced-draft evaporative condensers.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of evaporative condensers and are based on the specific system indicated. Retain subparagraph below with either "Product Options" Paragraph above or revise to suit Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: Fabricate and label heat-exchange coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Comply with NFPA 70.

E. Units shall be designed to operate with HCFC-free refrigerants.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, pressure drop, fan performance data, installation instructions, furnished specialties, and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include handrails, ladders, and equipment mounting frame.
3. Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field piping and wiring connection.


C. Manufacturer Seismic Qualification Certification: Submit certification that evaporative condensers, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

D. Operation and Maintenance Data: For evaporative condensers to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

F. LEED Submittals:

1. Credit EA 4: Manufacturers' product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:


2.2 MANUFACTURED UNITS

A. Description: Factory-assembled and -tested, induced or forced-draft evaporative condensers.

B. Fabricate evaporative condenser mounting frame and attachments with reinforcement strong enough to resist evaporative condenser movement during a seismic event when evaporative condenser mounting frame is attached to the building structure.

C. Evaporative Condenser Characteristics and Capacities:
2. Internal Circuit:
   a. Refrigerant Type: R-407C or R-410A or HFC-134a
   b. Entering-Air Wet-Bulb Temperature: <Insert deg F.>
   c. Condensing Temperature: <Insert deg F.>
5. External-Circuit Circulating Pump Motor Electrical Characteristics: 240 480 <Insert other>-V ac, 3 phase, 60 Hz.
6. Number of Fans: Two
7. Fan Motor Electrical Characteristics: 240 480 <Insert other>-V ac, 3 phase, 60 Hz.
9. Basin Heater: Maintain 40 deg F external-circuit-water or glycol temperature at 0 deg F outside-air temperature.

### 2.3 MATERIALS

   1. Fasteners: Corrosion resistance equal to or better than materials being fastened.
   3. Welded Connections: Continuous and watertight.
   4. Rigging Supports: For handling evaporative condensers at construction site.

   1. Removable strainer with openings smaller than nozzle orifices.
   2. Overflow connection.

C. Tube Bundle Material and Construction: Carbon-steel, hot-dip galvanized after fabrication, Copper serpentine tubes designed for low pressure drop and free drainage of refrigerant; factory tested at 350-psig air pressure while underwater.
1. **ASME Coil:** Comply with requirements in ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bear the ASME "U" stamp.

D. **Drift Eliminator Material:** Galvanized sheet steel complying with ASTM A 653/A 653M, G235 coating designation with polymer coating.

E. **External-Water Distribution System:** Header pipe and removable branch pipes for even distribution of water over the coil.
   1. **Pipe Material:** Schedule 40, galvanized steel
   2. **Nozzles:** Removable brass with a maximum pressure drop of 12 psig

F. **Inlet Screen Material:** Hot-dip galvanized-steel mesh with polymer coating, mounted in removable frames.

G. **Draft Hood Material:** Galvanized steel according to ASTM A 653/A 653M, G235 coating designation with polymer coating.

2.4 **COMPONENTS**

A. **Water-Level Control:** Electric float switch; characteristics coordinated with solenoid-operated, makeup water valve.

B. **Fan(s):** Galvanized steel, centrifugal.
   1. **Drive:** Direct or belt.
   2. **Bearings:** Self-aligning ball bearings or bronze sleeve bearings with lubrication lines and fittings.
   3. **Vibration Cutout Switch:** Solid state, with adjustable time delay and NEMA 250, Type 4 enclosure.

C. **External-Circuit Circulating Pump:** Close-coupled, end-suction, single-stage, bronze-fitted, mechanical seal, centrifugal pump; with a totally enclosed, fan-cooled motor; and suitable for outdoor service.

D. **Capacity-Control Dampers:** Galvanized-steel, fan-discharge dampers, with linkages, electric damper operator, controller, end switches, transformer, and weatherproof enclosure. Reset
dampers to vary airflow through evaporative condenser to control leaving condenser-water temperature.

E. Basin Heater: Steam injector or Electric-resistance coil.

2.5 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type Totally-enclosed air over.

C. Motor Speed: Inverter type for variable-speed controller.

2.6 HANDRAILS, LADDERS, AND PLATFORMS

A. Handrails: Galvanized steel or aluminum complying with 29 CFR 1910.23. Pipe-rail materials and fabrication are specified in Division 05 Section "Pipe and Tube Railings."

B. Ladders and Safety Cages: Galvanized steel or aluminum complying with 29 CFR 1910.27.

C. Platforms: Galvanized steel with a bar grating floor.

END OF SECTION 236333
DIRECT-FIRED ABSORPTION WATER CHILLERS
SECTION 236413.13 - DIRECT-FIRED ABSORPTION WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, direct-fired, double-effect absorption water chillers, with gas burners, with the following features:

1. Microprocessor-based controls complying with ASHRAE 135.
2. Charge of lithium bromide, refrigerant (Distilled or deionized water)
3. Startup supervision.
4. Training for owner's staff.
5. Disassembled suitable for rigging.
6. Disassembly and reassembly supervision.

1.2 QUALITY ASSURANCE


B. ASME Compliance: Fabricate and label water chiller pressure vessels to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Comply with NFPA 31.

D. Comply with NFPA 54.

E. Comply with NFPA 70.

F. UL Compliance: Comply with UL 465.

G. AGA Compliance: Comply with AGA requirements for gas-train devices and sequences.

H. FM Compliance: Comply with control device and sequence requirements of FM.
I. Chiller shall comply with New York City Building Code and contain an MEA #

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, shipping and operating weights furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Operating weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping, wiring, and vent connections.
5. Detail equipment assemblies and indicate dimensions, weights, load distribution, piping arrangement, method of field assembly, components and location and size of each field connection.
6. Motor controllers
7. Description of controls

8. Vibration Isolation Calculations and Details: Signed and sealed by a qualified professional engineer.

   a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   b. Vibration Isolation Base Detail: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

9. Wiring Diagrams: For power, signal, safety and control wiring. Differentiate between manufactured installed wiring and field installed wiring.

10. Structural supports.
11. Piping roughing-in requirements.
12. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
13. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

C. Certificates: For certification required in "Quality Assurance" Article.
D. Manufacturer Seismic Qualification Certification: Submit certification that water chillers, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

E. Source quality-control test reports.

F. Startup service reports.

G. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
   1. Include the following items as a minimum for the equipment.
      a. Parts list.
      b. Maintenance guide.
      c. Preventive maintenance schedule.
      d. Sequence of operation.
      e. Performance data.
      f. Lubrication schedules

H. Warranties

I. Factory Quality Control Test Reports

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Broad
   3. Thermax
   4. Trane
2.2  PACKAGED WATER CHILLERS

A. Description: Factory-assembled and -tested water chiller complete with generator, evaporator, absorber, condenser, controls, solution pump, purge system, interconnecting unit piping and wiring, indicated accessories, and mounting frame.

B. Refrigerant: Distilled or deionized water.

C. Absorbent: Lithium bromide.

D. Fabricate water chiller mounting frame and attachment to the pressure vessel with reinforcement strong enough to resist water chiller movement during a seismic event when the water chiller mounting frame is anchored to the building structure.

1. Disassemble chillers into major subassemblies for shipping and moving into building.

2. Be suitable for vertical rigging.

3. Be completely factory assembled, piped and wired and shipped as a packaged assembly requiring no field assembly except as noted.

4. Be mounted on a structural steel base, and have all exposed surfaces finished with gray primer or equal.

5. Meet or exceed the performance data indicated on the drawings.

6. Be suitable for installation, operation, maintenance and repair in the space conditions indicated on the drawings. All components shall be fully serviceable in place, and shall have lifting lugs as required.

2.3  SHELL

A. Construction: Fabricated from carbon steel, ASME labeled.


3. Tube Sheets: Carbon-steel plates; drilled and reamed for tubes.
2.4 HEAT EXCHANGERS

A. Tube Construction: Individually replaceable, expanded into tube sheets.

B. Evaporator:
   1. Tube Materials: Copper
   2. Diameter and Thickness: 3/4-inch- (19-mm-) OD tubing with 0.028-inch (0.7-mm) wall thickness.
   4. Expand tubes into tube sheets.
   5. Tubes: Individually replaceable.

C. Water Box:
   1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
   4. Hinged or davited marine water-box covers.
   6. Nozzles with flanges rated for design pressure.
   7. Design pressure: 150 psig (1040 kPa).
   8. Thermistor or RTD temperature sensor factory installed in each nozzle.
   9. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

D. Additional Corrosion Protection:
   1. Electrolytic corrosion-inhibitor anode.
   2. Coat wetted surfaces with a corrosion-resistant finish.

E. Condenser:
   1. Tube Materials: Copper
   2. Diameter and Thickness: 3/4-inch- OD tubing with 0.035-inch wall thickness.
   4. Expand tubes into tube sheets.
5. Tubes: Individually replaceable.

6. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

7. Standard Marine type for water box with piping connections. Standard type for water box without piping connections.

8. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.

9. Hinged or davited marine water-box covers.


11. Nozzles with flanges rated for design pressure.

12. Design pressure: 150 psig

13. Thermistor or RTD temperature sensor factory installed in each nozzle.

14. Fit each water box 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

F. Additional Corrosion Protection:

1. Electrolytic corrosion-inhibitor anode.

2. Coat wetted surfaces with a corrosion-resistant finish.

G. Absorber:

1. Tube Materials: Copper

2. Diameter and Thickness: 3/4-inch OD tubing with 0.028-inch wall thickness.

3. Maximum Working Pressure: 15 psig

4. Expand tubes into tube sheets.

5. Tubes: Individually replaceable.

6. Water Box: Marine with design working pressure of 150 psig and having flanged water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle.

H. First-Stage Generator:


2. Wall Thickness: 0.138 inch


PERFORM A STACK CALCULATION to determine if adequate draft exists in the flue / stack.

I. Burner Assembly:
1. Forced draft, single- or dual-fuel type; welded stainless-steel construction.
3. UL approved.
4. Flame safeguard.
5. Fuel: Natural gas.
6. Burner shall be welded steel construction. The combustion head shall incorporate a multi blade, stainless steel, flame retention diffuser. The gas firing head shall be of the multiport type and constructed such as to place annular gas distribution openings between two parallel air flow streams to achieve maximum fuel/air mixing.
7. The design shall be of the multi-nozzle, dual annular type which includes an adjustable premix air/gas chamber constructed such that a mixture of primary air and gas will be introduced into the combustion area, upstream of the secondary combustion air and ignition introduction zone.
8. Combustion air shall be supplied by an integrally mounted blower assembly incorporating a direct drive 3 phase motor. A dual blade damper assembly located on the inlet side of the blower wheel shall meter the combustion air flow. Design shall permit the disconnecting and locking of either damper if firing rates are at minimum burner input ratings. Damper blade axle shafts shall utilize brass sleeve bearings.
9. The burner ignition system which will light the main gas flame shall utilize natural gas as the pilot fuel source. The gas pilot system components shall include spark ignited pilot assembly, 600 volt ignition transformer, pilot solenoid valve, pilot gas pressure regulator and manual gas shutoff cock. The flame proving system shall incorporate an ultraviolet flame detector which will monitor both the pilot and main flames. The pilot assembly shall fit within the confines of the blast tube avoiding special burner front plate pilot cut outs.
10. For gas fired units the fuel/control system shall be of the full modulation type. The main On-Off gas supply shall be controlled by dual motorized gas valves. A modulating motor shall control the modulated positioning of the air inlet dampers and butterfly type gas proportioning valve to best meet system load conditions.
11. The gas control train shall be pre-piped and prewired with suitable junction boxes and terminal strips to burner panel terminal connections. The gas train shall contain the following components: manual shutoff cock, main gas pressure regulator, low and high gas pressure switches, two (2) UL listed leak test cocks, burner manifold gas pressure gauge, two (2) main motorized gas valves (for gas inputs of 5.0 MMBTU/HR and lower), two (2) main motorized gas valves – one (1) with proof of closure interlock switch (for gas inputs above 5.0 MMBTU/HR), and one (1) normally open vent valve sized according to IRI requirements.
12. Pre-purge operation of the modulating motor shall provide an electrical interlock at the 60% air flow position of the burner damper and another electrical interlock at the damper low fire start position before the ignition sequence will begin.

13. The flame safeguard control shall provide fully automatic pre-purge and post purge sequencing of the burner blower motor, interrupted ignition system, and fuel/air flow components with an ultra-violet sensor for flame detection. The flame safeguard control shall be Honeywell Model R414OL or approved equal.

14. Gas Train: AGA and FMG approved, consisting of manual-shutoff valve, main gas regulator, low and high gas-pressure switches, and two leak-test valves.
   a. The entire gas train shall comply with AGA and IRI.

J. Second-Stage Generator:

1. Tube Materials: Copper
2. Diameter and Thickness: 3/4-inch OD tubing with 0.028-inch (wall thickness.
4. Expand tubes into tube sheets.
5. Tubes: Individually replaceable.

K. Evaporator and Absorber Nozzle Materials: Stainless steel or other noncorrosive material.

2.5 INSULATION

A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.

1. Thickness: 1-1/2 inches
2. Adhesive: As recommended by insulation manufacturer.
3. Factory supplied insulation over entire cold surface of water chiller components.

   a. Apply adhesive to 100 percent of insulation contact surface.
   b. Seal seams and joints.
   c. After adhesive has fully cured, apply two coats of protective coating to insulation.


1. Thickness: 1-1/2 inches.
2. Factory apply insulation materials, accessories, and finishes; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment.

3. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized-steel plate, pin, and washer manufactured for attachment to water chiller's hot surfaces with adhesive. Pin length sufficient for insulation thickness indicated.
   a. Adhesive: Recommended by anchor pin manufacturer as appropriate for surface temperatures of water chillers; and with 100-lb holding capacity for direct pull perpendicular to adhered surface.


5. Jacket: Factory apply glass-cloth jacket, directly over insulation.
   a. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   b. Embed glass cloth between two 0.062-inch-thick coats of jacket manufacturer's recommended adhesive.
   c. Completely encapsulate insulation with jacket, leaving no exposed insulation.
   d. Apply two coats of latex paint to glass-cloth jacket.

2.6 ACCESSORIES

A. Solution Pump: Hermetically sealed, self-lubricating, and liquid cooled.
   a. Solution Pumps: Chiller shall be equipped with hermetically sealed, self-lubricating, (dual) motor-pump assemblies, starters, factory-mounted, piped, wired and tested. Both the refrigeration pump and the solution pump shall be provided with isolation valves on both the suction and discharge sides.

B. Purge System: Unit mounted and factory wired, equipped with a pump and controls to constantly remove non-condensable vapors.

C. Control Valve: Cast-iron or carbon-steel body, with PTFE seat and flanged connections, suitable for energy source specified, and with actuator and linkage.
   1. Actuator and Linkage: Capable of modulating flow from 20 to 100 percent.

D. Flue Draft Damper
   1. Furnish and install a factory-manufactured draft damper in the chiller breeching; include all required controls integrated with the chiller control system.
   2. Emergency Switch: Break glass type, single pole, double throw, suitable for 250 volts, rated at 10 amps at 125 volts AC, surface mounted, aluminum construction with
a hammer and chain, with a red finish. Cover designation shall read, “To Stop Burner” ASCO Model 124302.

2.7 CONTROLS

A. Control Panel: Stand-alone, microprocessor based.

B. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad. Display the following conditions:
   1. Date and time.
   2. Operating or alarm status.
   3. Operating hours.
   4. Outside-air temperature if required for chilled-water reset.
   5. Temperature and pressure of operating set points.
   6. Entering and leaving temperatures of chilled water and condenser water.
   7. Entering and leaving hot-water temperatures.
   8. Refrigerant temperature.
   9. Solution concentration and temperature.
   10. First-stage generator pressure and temperature.
   11. Indication of solution- and purge-pump operation.
   12. Generator shell pressure.
   13. Number of starts.
   14. Number of purge cycles.

C. Burner Control Panel: The Burner Control Panel enclosure shall be constructed of 16 gauge steel and shall be equipped with a hinged and removable front access door and shall house all combustion related safeties and control logic. The Burner Panel shall be designed to interface directly with the Temperature Control Center Panel to provide integrated burner control for the chiller. The Burner Control Panel shall be pre-mounted and prewired to the chiller and shall include the following components:
   1. Honeywell R4140L or approved equal flame safeguard
   2. Burner On/Off Switch
   3. 115V Control power transformer
   4. Motor starters, complete with current overload protection for blower motor and remote oil pump (if used)
   5. Electrical transient suppressors
   6. Alarm bell
   7. Flame failure indication contacts
8. Exhaust gas temperature limit switch  
   a. Remote exhaust gas temperature sensor to be field wired and installed in exhaust breeching.

9. Indicating lamps, labeled as follows:  
   a. Call for Operation  
   b. Ignition On  
   c. Main Fuel  
   d. Flame Failure

D. Control Functions:  
1. Automatically control burner-firing rate to maintain chilled-water or hot-water temperature set points.
2. Entering and leaving chilled-water temperatures and control set points. Chilled-water temperature shall be reset based on return-water temperature.
3. Operate solution and refrigerant pumps for several minutes after heat-input valve is closed to ensure crystallization does not occur.
4. Crystallization Guard: Automatic cycle to prevent crystallization during operation of chiller.
5. Cooling energy use in ton-hours within programmable time periods, minimum monthly.

E. Safety Shutdowns:  
1. Low refrigerant temperature.  
2. Loss of chilled- or condenser-water flow.  
3. Low leaving chilled-water temperature, 2 deg F below set point.  
5. Solution-pump overloads.  
7. First-stage generator high temperature or pressure.  
8. High solution concentration.  
9. Incomplete dilution cycle.  

F. Warning Conditions: Control panel shall close warning contacts and generate a message when one of the following operating conditions is detected:  
1. Low refrigerant temperature.  
2. High generator temperature or pressure.  
3. High or low entering condenser-water temperature.  
4. Purge-pump current overload.
5. Solution temperature sensor failure.
6. Low chilled-water flow.

G. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

H. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

I. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

J. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

K. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

1. ASHRAE 135 BACnet communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

2.8 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Being source quality-control tested. Notify Architect or engineer 14 days in advance of testing.

END OF SECTION 236413.13
CENTRIFUGAL WATER CHILLERS
SECTION 236416 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.
   2. Packaged, portable refrigerant recovery units.
   3. Heat-exchanger, brush-cleaning system.
   4. Refrigerant (full charge) and oil
   5. Startup supervision.
   6. Training for owner's staff.
   7. Disassembled suitable for rigging.
   8. Disassembly and reassembly supervision.

1.2 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 certification program.

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASHRAE Compliance:
   1. ASHRAE 15 for safety code for mechanical refrigeration.
   2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1

E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.

F. Comply with NFPA 70.
G. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.

H. Green Seal Compliance: Signed by manufacturer Green Seal certifying compliance with GS-31.

I. Chiller shall comply with New York City Building Code and contain an MEA #

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, shipping and operating weights furnished specialties, and accessories.

B. LEED Submittal:
   1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, piping arrangement, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, safety and control wiring. Differentiate between manufactured installed wiring and field installed wiring.
   3. Motor controllers
   4. Description of controls
   5. Vibration isolation:
      a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights as required.
      c. Coordinate with vibration and acoustic consultants
   7. Piping roughing-in requirements.
   8. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
9. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
10. Refrigerant piping.

D. Certificates: For certification required in "Quality Assurance" Article.

E. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

F. Factory quality-control and test reports.

G. Startup service reports.

H. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.
   1. Include the following items as a minimum for the equipment.
      a. Parts list.
      b. Maintenance guide.
      c. Preventive maintenance schedule.
      d. Sequence of operation.
      e. Performance data.
      f. Lubrication schedules.

I. Warranty: Sample of special warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation.
   2. McQuay
2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, heat-reclaim condenser as indicated, controls, interconnecting unit piping and wiring, and indicated accessories.

1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

2. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

B. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

1. Disassemble chillers into major subassemblies for shipping and moving into building.

2. Be suitable for vertical rigging.

3. Be completely factory assembled, piped and wired and shipped as a packaged assembly requiring no field assembly except as noted.

4. Be mounted on a structural steel base, and have all exposed surfaces finished with gray primer or equal.

5. Meet or exceed the performance data indicated on the drawings.

6. Be suitable for installation, operation, maintenance and repair in the space conditions indicated on the drawings. All components shall be fully serviceable in place, and shall have lifting lugs as required.

2.3 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.
Retain subparagraph below for proprietary product using oil-free compressor technology. See Evaluations.

1. Where indicated, provide oil-free compressor technology using a permanent magnet synchronous motor, magnetic bearings, integral variable frequency controller, and digital electronic controls.

B. Compressor:

1. Casing: Cast iron, precision ground, designed for a minimum working pressure of 200 psig and hydrostatic pressure tested at a minimum of 300 psig
2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.
   a. The impeller shall be designed for balanced thrust and is dynamically balanced and over speed tested for smooth, vibration free operation.

C. Drive Direct- or gear-drive, open or hermetic design using an electric motor as the driver.

1. Gear Drives: For chillers with gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating. Gears shall comply with American Gear Manufacturer Association standards.
   a. Internal single helical gears with crowned teeth shall be designed so that more than one tooth is in contact at all times to provide even distribution of the compressor load. Each gear shall be individually mounted in its own journal and thrust bearings to isolate it from impeller and drive forces.
2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
   a. Open drive compressors shall be furnished with shaft seals consisting of a spring loaded, precision carbon ring, high temperature elastomer O-ring static seal, and stress relieved, precision lapped collars. The seal shall feature a small face area and low rubbing speed. It shall provide an efficient seal under high pressure conditions. The seal shall be oil flooded at all times and pressure lubricated during compressor operation.
3. Seals: Seal drive assembly to prevent refrigerant leakage.
4. The compressor shaft shall be laser aligned to the speed increaser in the factory.
5. Insert type journal bearings shall be split sleeve, steel back fabricated of aluminum alloy, precision bored and axially grooved.
6. Thrust bearings shall be tilting pad self-leveling, aluminum allow, Kingsbury type with equalizer piston.
7. All bearings, gears and related components shall have sufficient capacity to transmit maximum compressor load under all operating conditions with vibration not to exceed 1.0 mil.

8. Speed Increaser Gear for Open Drive Machines:
   a. The system driveline shall be equipped with a factory aligned speed increaser gear that will increase the rotating speed from full load motor RPM to optimized RPM required by the low speed shaft of the compressor.
   b. The design of the speed increaser shall insure that excessive torsional vibration levels are not transmitted to the compressor at all operating speeds.
   c. The speed increaser shall be supplied with face hardened, double helical gears and sleeve bearings and shall be laser aligned to the motor.
   d. Temperature rise shall not exceed 70°F above ambient at full load.

9. Torsional Coupling for Open Drive Machines:
   a. A torsional coupling shall be supplied to assure that excessive torsional vibration levels are not transmitted to the speed increaser and compressor at all operating speeds.
   b. Coupling shall have sufficient capacity to transmit maximum compressor load under all operating conditions with vibration not to exceed 1.0 mil.
   c. Furnish coupling guards

D. Compressor Motor:

1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping. The rotor assembly shall be dynamically and statically balanced after fabrication and tested to a minimum 20 percent over-speed.
3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. Motor shall be suitable for use with specified motor controller as described in this specification, fully serviceable without disassembling compressors, suitable for on-off cycling at 30 minute intervals continuously without damage, sized so that full load operating amps do not exceed nameplate amps, and guaranteed by manufacturer for continuous operation at maximum brake horsepower when driving the refrigeration compressor. The motor shall be built for connection to and functionally compatible with specified starter.
5. For chillers with open drives, provide motor with totally enclosed enclosure.
6. Provide motor with thermistor or RTD in single motor winding each of three-phase motor windings to monitor temperature and report information to chiller control panel.

7. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

8. Provide motor lifting lugs.

9. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.

E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range. Vibration shall not exceed 1.0 mil at compressor housing.

1. Operating speed shall be below first critical speed.

2. Over speed Test: 25 percent above design operating speed.

F. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.

2. Provide lifting lugs or eyebolts attached to casing.

G. Economizers: For multistage chillers, provide inter-stage economizers.

H. Capacity Control: Modulating, variable-inlet, guide-vane assembly without hot-gas bypass, to achieve performance indicated.

1. Guide vanes shall be air foil shaped, stainless steel or non-ferrous alloy, supported by high quality, heat treated stainless steel or non-ferrous alloy shafts. Positive seal shall be used at points where vane operating mechanism passes through the compressor casing. Provide external electric valve operator and linkage.

2. Motor speed and pre-rotation vane position shall be automatically controlled by the chiller control panel to maintain leaving chilled liquid temperature at the desired set-point without overloading the motor. Motor speed shall be set to optimize energy efficiency.

3. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.

4. Operating Range: From 100 to 10 percent of design capacity.

5. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 deg F for each 10 percent in capacity reduction.

6. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
7. The chiller shall be capable of extended operation with 55°F entering condenser water temperature without the use of condenser flow reduction or cooling tower fan cycling. Chiller manufacturer shall provide a written guarantee, signed by an officer of the company that the chiller will operate continuously with full condenser flow at low entering condenser water temperatures. Any problems associated with such operation will be corrected at no charge to the owner for the life of the equipment. No condenser flow bypass or flow reduction is permitted, as this will accelerate the fouling of the condenser tubes.

I. Oil Lubrication System: Consisting of pump, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, coast down, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Dual oil filters, one redundant, shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
4. Refrigerant- or water-cooled oil cooler.
5. Factory-installed and pressure-tested piping with isolation valves and accessories.
6. Oil compatible with refrigerant and chiller components.
7. Positive visual indication of oil level.
8. Forced circulation type, completely piped and wired except as noted herein with all components necessary to assure positive oil supply on start-up, normal operation, shutdown, and power failure, including oil pump, cooler, filter, pressure gauge, thermometer, sight ports, heater, motor controller and controls. Lubrication oil shall be force-fed to all bearings, gears, and rotating surfaces by an oil pump which operates prior to start-up and continuously during operation and during coast down. A gravity-fed oil reservoir shall be built in to the top of the compressor to provide lubrication during coast down in the event of a power failure. An oil reservoir, separate from the compressor, shall contain a submersible oil pump and two immersion-type oil heaters, thermostatically controlled to remove refrigerant from the oil. Oil shall be filtered by an externally mounted replaceable cartridge oil filter equipped with service valves, and cooler by a water cooled oil cooler before entering the compressor. Oil piping on the driveline shall be completely factory installed. Interconnecting oil piping between the shell and driveline skid shall be provided for field installation.

2.4 REFRIGERATION

A. Refrigerant:
1. Type: R-123 or R-134a; ASHRAE 34, Class A1 or Class B1. Provide a full charge of refrigerant and oil.

2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

3. Provide refrigerant charging port in refrigerant circuit.

B. Refrigerant Flow Control: Manufacturer’s standard refrigerant flow-control device satisfying performance requirements indicated.

1. The flow of liquid refrigerant between the condenser and evaporator shall be controlled through a single variable orifice.

2. The variable orifice shall automatically adjust to maintain proper refrigerant charge levels in the condenser and evaporator.

3. The variable orifice shall be controlled by a modulating motor which works in conjunction with the pre-rotation vanes and the liquid level sensor in the condenser to maintain the proper amount of liquid refrigerant under both full and part load conditions.

C. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. For Chillers Using R-123: Spring-loaded, pressure relief valve; single- or multiple-reseating type.

3. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

E. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

F. Purge System:
1. For chillers operating at sub-atmospheric pressures (using R-123 refrigerant), factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of non-condensables including, but not limited to, water, water vapor, and non-condensable gases.

2. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.

3. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.


5. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.

6. Efficiency of not more than 0.02 lb of refrigerant per pound of air when rated according to ARI 580.

7. Operation independent of chiller per ASHRAE 147.

G. Positive-Pressure System:

1. For chillers operating at sub-atmospheric pressures (using R-123 refrigerant), factory install an automatic positive-pressure system.

2. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (adjustable) up to a pressure that remains within the vessel design pressure limits.

3. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

2.5 EVAPORATOR

A. Description: Flooded type shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Design pressures:

   1. Refrigerant side:
      a. For refrigerant R134a: 180 psig working pressure, 235 psig test pressure.
b. For refrigerant R123: 50 psig working pressure, 65 psig (450 kPa) test pressure.

2. Water side:
   a. 150 psig working pressure, 195 psig test pressure.

3. Refrigerant and water side designed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division I.

F. Tubes:
   1. Tubes: High efficiency type, seamless.
      a. The O.D. shall be nominal with the wall thickness measured at the root of the fin.
      b. No external fins at the tube sheets and at the intermediate tube sheets.
      c. Maximum tube velocity is 10 feet per second.

2. Individually replaceable from either end and without damage to tube sheets, other tubes, or causing leakage at adjacent tubes.

3. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.

4. Material: Copper


6. Minimum Wall Thickness: 0.035 inch

7. External Finish: Enhanced or smooth.

8. Internal Finish: Enhanced or smooth.

G. End Tube Sheets: Double groove, continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

H. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration, not greater than 5'-0" and to avoid contact of tubes resulting in abrasion and wear.

I. Water Box:
   1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
4. Hinged or davited marine water-box covers.
6. Nozzles with flanges rated for design pressure.
7. Design pressure: 150 psig (1040 kPa).
8. Thermistor or RTD temperature sensor factory installed in each nozzle.
9. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

J. Additional Corrosion Protection:
   1. Electrolytic corrosion-inhibitor anode.
   2. Coat wetted surfaces with a corrosion-resistant finish.

2.6 CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed with baffles to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes. Designed to uniformly distribute gas refrigerant over the length of the condenser.

D. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Provide liquid sub-cooling connections for purge and recovery unit.

F. Tubes:
   1. Tubes: High efficiency type, seamless.
      a. The O.D. shall be nominal with the wall thickness measured at the root of the fin.
      b. No external fins at the tube sheets and at the intermediate tube sheets.
      c. Maximum tube velocity is 10 feet per second.
2. Individually replaceable from either end and without damage to tube sheets, other tubes, or causing leakage at adjacent tubes.
3. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
4. Material: Copper
6. Minimum Wall Thickness 0.035 inch
7. External Finish: Enhanced or smooth.
8. Internal Finish: Enhanced or smooth.

G. End Tube Sheets: Double groove, continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

H. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration, not greater than 5'-0" and to avoid contact of tubes resulting in abrasion and wear.

I. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
4. Hinged or davited marine water-box covers.
6. Nozzles with flanges rated for design pressure.

7. Design pressure: 150 psig (1040 kPa).

8. Thermistor or RTD temperature sensor factory installed in each nozzle.
9. Fit each water box 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

J. Additional Corrosion Protection:

1. Electrolytic corrosion-inhibitor anode.
2. Coat wetted surfaces with a corrosion-resistant finish.
2.7 HEAT-RECLAIM CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator and condenser.

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed with baffles to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes. Designed to uniformly distribute gas refrigerant over the length of the condenser.

D. Tubes:
   1. Tubes: High efficiency type, seamless.
      a. The O.D. shall be nominal with the wall thickness measured at the root of the fin.
      b. No external fins at the tube sheets and at the intermediate tube sheets.
      c. Maximum tube velocity is 10 feet per second.
   2. Individually replaceable from either end and without damage to tube sheets, other tubes or causing leakage at adjacent tubes.
   3. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
   5. Minimum Wall Thickness 0.035 inch
   7. Internal Finish Enhanced or smooth

E. End Tube Sheets: Double groove, continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

F. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration, not greater than 5'-0" and to avoid contact of tubes resulting in abrasion and wear.

G. Water Box:
   1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
4. Hinged or davited marine water-box covers.
6. Nozzles with flanges rated for design pressure.
7. Design pressure: 150 psig (1040 kPa).
8. Thermistor or RTD temperature sensor factory installed in each nozzle.
9. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

H. Additional Corrosion Protection:
   1. Electrolytic corrosion-inhibitor anode.
   2. Coat wetted surfaces with a corrosion-resistant finish.

2.8 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Thickness 1-1/2 inches

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
   1. Apply adhesive to 100 percent of insulation contact surface.
   2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
   3. Seal seams and joints to provide a vapor barrier.
   4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
2.9 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.
   1. Electrical Power: 208 volts; 3 phase, 60 Hz
   2. Electrical Power: 460 volts, 3 phase, 60 Hz
   3. Electrical Power: 2,300 volts, 3 phase, 60 Hz
   4. Electrical Power: 4,160 volts, 3 phase, 60 Hz.
   5. Electrical Power: 13,800 volts, 3 phase, 60 Hz.

B. Single-point, field-power connection to fused disconnect switch Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
   1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.
      a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
      b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.
   2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
   3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch length of liquid-tight or flexible metallic conduit.

E. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95 at all operating conditions.
1. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.

2. Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAR ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.

3. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.

4. Provide a ground terminal and a terminal block or individual connectors for phase connection.

2.10 MOTOR CONTROLLER

A. Enclosure: Factory installed, unit mounted NEMA 250, Type 4 with hinged full-front access door with lock and key or padlock and key.

B. Control Circuit: Obtained from integral control power transformer with a control power transformer of enough capacity to operate connected control devices.

C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.

D. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, non-reversing; include isolation switch and current-limiting fuses.

E. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.

F. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition; include isolation switch and current-limiting fuses.

G. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.

1. Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

2. Visual indication of motor and control status, including the following conditions:
   a. Controller on.
   b. Overload trip.
   c. Loss of phase.
d. Starter fault.

H. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Externally Operated Door-Interlocked Disconnect: Fused disconnect switch Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
3. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
5. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
7. Meters: Panel type, 2-1/2 inches with 90, 120, 270-degree scale and 1 percent accuracy. Where indicated, provide transfer device with an off position. Meters shall indicate the following:
   a. Ammeter: Output current for each phase, with current sensors rated to suit application.
   b. Voltmeter: Output voltage for each phase.
   c. Frequency Meter: Output frequency.
   d. Real-time clock with current time and date.
   e. Total run time.
8. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   a. Selectable, digital display of the following:
      1) Phase Currents, Each Phase: Plus or minus 1 percent.
      2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      4) Three-Phase Real Power: Plus or minus 2 percent.
      5) Three-Phase Reactive Power: Plus or minus 2 percent.
      6) Power Factor: Plus or minus 2 percent.
      7) Frequency: Plus or minus 0.5 percent.
      8) Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.
9) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

b. Mounting: Display and control unit flush or semi-recessed in instrument compartment door.


2.11 VARIABLE FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 4 with hinged full-front access door with lock and key.

D. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

E. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

F. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.

2. Regulator shall provide full digital control of frequency and voltage.

3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.
G. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

H. Operating Requirements:

1. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum
2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
3. Capable of driving full load, without derating, under the following conditions:
   a. Ambient Temperature: 0 to 50 deg C.
   b. Relative Humidity: Up to 90 percent (noncondensing).
   c. Altitude: 3300 feet
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
6. Overload Capability: 1.05 times the full-load current for 7 seconds.
7. Starting Torque: As required by compressor-drive assembly.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

I. Internal Adjustability Capabilities:

1. Minimum Output Frequency: 6 Hz.
2. Maximum Output Frequency: 60 Hz.
3. Acceleration: 2 seconds to a minimum of 60 seconds.
4. Deceleration: 2 seconds to a minimum of 60 seconds.
5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

J. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

1. Over-temperature.
2. Short circuit at controller output.
3. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
4. Open circuit at controller output.
5. Input under-voltage.
6. Input over-voltage.
7. Loss of input phase.
8. Reverse phase.
9. AC line switching transients.
10. Instantaneous overload, line to line or line to ground.
11. Sustained overload exceeding 100 percent of controller rated current.
12. Starting a rotating motor.

K. Motor Protection: Controller shall protect motor against overvoltage and under-voltage, phase loss, reverse phase, overcurrent, over-temperature, and ground fault.

L. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and under-voltage trips.

M. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
11. Input kilovolt amperes.
12. Total power factor.
13. Input kilowatts.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage total harmonic distortion.
20. Three-phase input current total harmonic distortion.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

N. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

P. Input Line Conditioning:

Q. Cooling: Air, refrigerant, or water cooled.

R. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

   1. Control Relays: Auxiliary and adjustable time-delay relays.

S. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

2.12 CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

B. The control panel is to be unit-mounted. The panel is to be factory wired with a single-point power connection and separate control circuit.

C. Enclosure: Unit mounted, NEMA 250, Type 4hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

D. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure.
In either imperial or metric units selectable through the interface, display the following information:

1. Date and time.
2. Operating or alarm status.
3. Fault history with not less than last 10 faults displayed.
4. Set points of controllable parameters.
5. Trend data.
6. Operating hours.
7. Number of chiller starts.
8. Outdoor-air temperature or space temperature if required for chilled-water reset.
10. Difference in fluid temperatures of evaporator and condenser.
11. Fluid flow of evaporator and condenser.
12. Fluid pressure drop of evaporator and condenser.
13. Refrigerant pressures in evaporator and condenser.
14. Refrigerant saturation temperature in evaporator and condenser shell.
15. Compressor refrigerant suction and discharge temperature.
16. Compressor bearing temperature.
17. Motor bearing temperature.
18. Motor winding temperature.
19. Oil temperature.
20. Oil discharge pressure.
21. Compressor oil tank pressure
22. Differential oil pressure
23. Phase current.
25. Phase voltage.
26. Demand power (kilowatts).
27. Energy use (kilowatt-hours).
29. For chillers equipped with variable frequency controllers and harmonic filters, include the following:

   a. Output voltage and frequency.
   b. Voltage total harmonic distortion for each phase.
   c. Supply current total demand distortion for each phase.
   d. Inlet vane position.
   e. Controller internal ambient temperature.
   f. Heat sink temperature.
30. Purge suction temperature if purge system is provided.
31. Purge elapsed time if purge system is provided.
32. Purge pumpout rate
33. Total purge pumpout time.

E. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on return-water temperature.
3. Evaporator freeze protection and low limit control. This control shall be used to avoid low evaporator refrigerant temperature trip outs during critical periods of chiller operation. The control shall take progressively more aggressive load limiting action in response to the severity of the rate of change and the actual value of the evaporator refrigerant temperature. A clear language diagnostic message, reflecting the operating status, shall be automatically displayed at the front panel whenever this control is in effect, and if the condition exists for more than 20 minutes, a limit warning alarm relay shall energize to indicate that the condition has persisted.

4. Individual relay outputs to prompt the plant engineer to start/stop the chilled water pump and condenser water pump. The condenser water pump relay output can be used to enable the cooling tower temperature controls.
5. A relay output that shall energize whenever the compressor is running.
6. An alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
7. A relay output that shall energize whenever the chiller is operating at maximum capacity.
10. External chiller emergency stop.
11. Variable evaporator flow.
12. Thermal storage.
14. Current chiller operating mode
15. Capable of providing variable interval timers for short cycling protection. The variable timers shall adjust to the critical chiller operating parameters and the time between successive attempted starts of the compressor motor. Fixed start-to-start short cycling protection timers are not acceptable.
16. Capable of independently invoking password protection of the entire display and keypad, operator settings (e.g. chilled water set-point), machine configuration settings, and service start-up settings.

17. Pre-rotation vane pulse rate observable through LED indication of compressor loading/unloading condition, battery backup to maintain all set-points for a month in case of power loss and heat exchanger efficiency display to identify tube cleaning/water treatment requirements.

18. Capability to control inlet guide vane position in response to chiller load requirements.

F. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

1. Low evaporator pressure and temperature; high condenser pressure.
2. Low evaporator fluid temperature.
3. Low oil differential pressure.
4. High or low oil pressure.
5. High oil temperature.
6. High compressor-discharge temperature.
7. Loss of condenser-fluid flow.
8. Loss of evaporator fluid flow.
9. Excessive motor starts
10. Motor overcurrent.
11. Motor overvoltage.
12. Motor under-voltage.
15. Sensor- or detection-circuit fault.
16. Processor communication loss.
17. Motor controller fault.
18. Extended compressor surge.
20. Compressor rotation fault.
22. Excessive air-leakage detection for chillers using R-123 refrigerant.
23. Manually reset safety controls.
24. Additional Features:
   a. Unit shall not start without minimum flow through evaporator and condenser.
b. Differential type flow switches shall be supplied by chiller manufacturer to shutdown unit when flow drops below minimum. Differential pressure flow switches shall be similar to SOR Inc. series 102.

c. Furnish controls to avoid chiller system cycling due to transient high and low pressure conditions by not allowing compressor to load for safe period of time. Persistent condition will allow chiller to shut down automatically.

d. Display shall denote high or low pressure condition as the governing chiller control factor.

e. Rejection of improper input which is potentially harmful to unit operation and corresponding display message.

f. To monitor bearing temperatures on hermetic machines, all of the compressor motor bearings, (including high speed, low speed, and thrust bearings) shall have factory installed temperature sensors installed in the oil return lines of each motor bearing. If any oil temperature reaches or exceeds a set value, the chiller control panel shall shut down the chiller, display the diagnostic, and light the front panel alarm LED.

g. The chiller control panel shall monitor the advanced motor protection system at the starter for the functions listed in compressor motor controllers.

h. The chiller control panel shall monitor the advanced motor protection system at the starter for the functions listed in compressor motor controllers.

G. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

H. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

I. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

J. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

K. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

1. ASHRAE 135 BACnet on LonTalk or Modbus Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely control...
and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

2.13 FINISH

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

1. Provide at least one coat of primer with a total dry film thickness of at least 2 mils.
2. Provide at least two coats of alkyd-modified, vinyl enamel finish with a total dry film thickness of at least 4 mils.
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat to be manufacturer's standard

B. Provide Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

2.14 ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.

2. Pressure Differential Switches:

   a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
   b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
   c. Set Point: Screw type, field adjustable.
   d. Electrical Connections: Internally mounted screw-type terminal blocks.
   e. Switch Enclosure: NEMA 250, Type 4 Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
B. Vibration Isolation:

1. Chiller manufacturer shall furnish vibration isolation for each chiller.

2. Neoprene Pad:
   
   a. Two layers of 0.375-inch thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
   
   b. Fabricate pads from 40- to 50-durometer neoprene.
   
   c. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

3. Spring Isolator:
   
   a. Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions. Isolators shall be designed so that the Kx/Ky ratio shall be 1.0 or more for stability.
   
   b. Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Aluminum components shall be etched and painted. Nuts, bolts, and washers shall be zinc electroplated.
   
   c. Isolators shall be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate. An elastomeric pad with a minimum thickness of 0.25 inch shall be bonded to the baseplate.
   
   d. Spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts shall not be engaged during normal operation and shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.
   
   e. Isolators shall be selected for a nominal 2-inch

C. Sound Barrier:

1. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.

2. Provide for repeated installation and removal without use of tape or caulk.

3. Inner and outer cover shall consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.

4. Covers shall be double sewn and lock stitched with edges folded and sewn so no raw cut edges are exposed.
5. Form covers around control devices, gages, conduit, piping, and supports without degrading sound-barrier performance.
6. Continuously lap all exposed seams at least 2 inches for better sound containment.
7. Permanently label each section of cover to indicate its location, description, size, and number sequence.
8. Randomly place stainless-steel quilting pins to prevent covers from shifting and sagging.

2.15 ACOUSTIC CRITERIA

A. Noise Rating: 85 dBA sound power level when measured according to ARI 575. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

B. Acoustic performance within spaces:

1. Equipment room noise levels and noise transmissions to adjacent buildings shall comply with all federal, state and local noise ordinances.

C. Refrigeration machine gear train acoustical performance:

1. The gear train assembly (between drive and compressor) when operating at the machine’s rated capacity per plans and specifications and tested in accordance with AGMA 295-02 shall have noise levels no exceeding 85 dBA.

D. Refrigeration machine acoustical performance:

1. The maximum permissible noise levels under design operating conditions when measured in accordance with ARI Standard 575-73 specified methods and qualifications, shall not exceed 85 dBA.

E. Motor acoustical performance:

1. Motor drive when installed per plans and specifications shall operate with noise levels not exceeding 85 dBA at 3 feet.

2. Noise levels shall be determined in accordance with IEEE Standard 85 test procedure of airborne noise measurements on rotating electrical equipment.
2.16 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

A. Furnish for field installation a brush-cleaning system on each chiller condenser for tube cleaning and improved heat transfer.

B. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.

C. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve’s actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.

D. Components:

1. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch.

2. Basket: Single-piece polypropylene basket with neck OD to press fit inner diameter of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.

3. Four-Way Valve:
   a. Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
   b. Configure valve with parallel flow connections to minimize field installation piping.
   c. Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.
   d. Pipe connections shall be flanged.
   e. Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.
   f. Hydrostatically test to 1.5 times the design working pressure.
   g. Design the valve to cause no more than 0.5-psig pressure drop at design flow conditions.
   h. Provide valve with valve-mounted indicating/warning light, which shall light before the valve begins rotation.
   i. Valve Actuator: Mount electric actuator to operate valve.
j. Position Switches: Factory mount micro-switches on the valve to indicate the complete turn of valve in both normal and reverse flow.

4. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:

   a. NEMA 250, Type 4 enclosure.
   b. Timer to automatically initiate the cleaning cycle over a 24-hour period.
   e. For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
   f. Flow switch bypass.
   g. Unloading signal to chiller.

2.17 SOURCE QUALITY CONTROL

   A. Perform functional run tests of chillers before shipping.

   B. For chillers using R-134a refrigerant, factory test and inspect evaporator and condenser condenser, and heat-reclaim condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

   C. For chillers using R-123 refrigerant, factory test and inspect evaporator and condenser condenser and heat-reclaim condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Pressure test fluid side of heat exchangers, including water boxes, to 1.5 times the rated pressure. Pressure proof test refrigerant side of heat exchangers to a minimum of 45 psig. Vacuum and pressure test for leaks.

   D. For chillers located indoors, rate sound power level according to ARI 575.

END OF SECTION 236416

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RECIPROCATING WATER CHILLERS
SECTION 236419 - RECIPROCATING WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, electric-motor-driven, reciprocating water chillers.
2. Packaged, air-cooled, electric-motor-driven, reciprocating water chillers.
3. Packaged refrigerant recovery units.

1.2 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 590 certification program.

B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

C. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
3. ASHRAE/IESNA 90.1 for energy efficiency.

D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 70.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings: Complete set of manufacturer’s prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distributions.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Certificates: For certification required in "Quality Assurance" Article.

D. Seismic Qualification Certificates: For water chillers, accessories, and components, from manufacturer.

E. Factory quality-control and test reports.

F. Startup service reports.

G. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

PART 2 - PRODUCTS

2.1 PACKAGED WATER-COOLED WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a United Technologies company.
2. York Corp.
3. Trane
4. McQuay
B. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.

C. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

D. Compressors:
   1. Description: Positive-displacement direct drive with semi-hermetically sealed and accessible bolted casings.
   2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
   3. Operating Speed: 1750 rpm for 60-Hz applications.
   4. Capacity Control: Combinations of cylinder unloading and on-off compressor cycling of multiple compressors, plus hot-gas bypass. Compressor shall be capable of operating at part-load conditions without increased vibration over normal vibration at full-load operation and shall be capable of continuous operation at its lowest step of unloading.
   5. Oil Lubrication System: Automatically reversible, positive-displacement pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
   6. Vibration Isolation: Mount individual compressors on either neoprene or spring isolators.
   7. Sound-reduction package shall consist of acoustic enclosures around the compressors that are designed to reduce sound level without affecting performance.

E. Compressor Motors:
   1. Hermetically sealed and cooled by refrigerant suction gas.
   2. High-torque, four-pole induction type with inherent thermal-overload protection on each phase.

F. Compressor Motor Controllers:
   1. Across the Line: NEMA ICS 2, Class A, full voltage, non-reversing.
   2. Part-Wind Start: NEMA ICS 2, Class A, reduced voltage, non-reversing.

G. Refrigeration:
   1. Refrigerant: R-22. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

3. Refrigerant Circuit: Each circuit shall include a thermal and electronic expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

H. evaporator:

1. Shell and Tube:
   a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
   b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
   c. Shell Material: Carbon steel.
   d. Shell Heads: Removable carbon-steel heads with multi-pass baffles designed to ensure positive oil return and located at each end of the tube bundle.
   e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with flanged end connections for connection to field piping.
   f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

2. Brazed Plate:
   a. Direct-expansion, single-pass, brazed-plate design.
   b. Type 316 stainless-steel construction.
   c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
   d. Fluid Nozzles: Terminate with flanged end connections for connection to field piping.

I. Condenser:

1. Shell and Tube:
   a. Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
b. Provides positive sub-cooling of liquid refrigerant.

c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.


e. Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with flanged end connections for connection to field piping.

f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

g. Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.

2. Provide water chiller without an integral condenser and design chiller for field connection to remote condenser. Coordinate requirements with Division 23 Section "Air-Cooled Refrigerant Condensers."

J. Electrical Power:

1. Factory-installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

2. House in a unit-mounted, NEMA 250, Type 1 enclosure with hinged access door with lock and key or padlock and key.

3. Wiring shall be numbered and color-coded to match wiring diagram.

4. Install factory wiring outside of an enclosure in a raceway.

5. Field power interface shall be to wire lugs NEMA KS 1, heavy-duty, nonfused disconnect switch.

6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:

   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

   b. NEMA KS 1, heavy-duty, non-fusible switch.

   c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.


10. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

11. Control Relays: Auxiliary and adjustable time-delay relays.

12. Indicate the following for water chiller electrical power supply:
   a. Current, phase to phase, for all three phases.
   b. Voltage, phase to phase and phase to neutral for all three phases.
   c. Three-phase real power (kilowatts).
   d. Three-phase reactive power (kilovolt amperes reactive).
   e. Power factor.
   f. Running log of total power versus time (kilowatt hours).
   g. Fault log, with time and date of each.

K. Controls:

1. Stand-alone, microprocessor based.

2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.

3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
   a. Date and time.
   b. Operating or alarm status.
   c. Operating hours.
   d. Outside-air temperature if required for chilled-water reset.
   e. Temperature and pressure of operating set points.
   f. Entering and leaving temperatures of chilled water.
   g. Entering and leaving temperatures of condenser water.
   h. Refrigerant pressures in evaporator and condenser.
   i. Saturation temperature in evaporator and condenser.
   j. No cooling load condition.
   k. Elapsed time meter (compressor run status).
   l. Pump status.
   m. Anti-recycling timer status.
   n. Percent of maximum motor amperage.
   o. Current-limit set point.
p. Number of compressor starts.

4. Control Functions:

a. Manual or automatic startup and shutdown time schedule.
b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return water temperature.
c. Current limit and demand limit.
d. Condenser-water temperature.
e. External water chiller emergency stop.
f. Anti-recycling timer.
g. Automatic lead-lag switching.
h. <Insert functions>.

5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

a. Low evaporator pressure or high condenser pressure.
b. Low chilled-water temperature.
c. Refrigerant high pressure.
d. High or low oil pressure.
e. High oil temperature.
f. Loss of chilled-water flow.
g. Loss of condenser-water flow.
h. Control device failure.

6. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display water chiller status and alarms.

a. ASHRAE 135 BACnet or LonTalk Industry-accepted open-protocol <Insert type of interface> communication interface with building management system shall enable building management system operator to control and monitor the water chiller from a remote operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building management system.

L. Insulation:
1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.

2. Thickness: 1 inch over cold surfaces of water chiller components.
   a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

3. Apply protective coating to exposed surfaces of insulation.

M. Accessories:

1. Factory-furnished, chilled-and condenser-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves.
3. Factory-furnished spring isolators for field installation.

N. Capacities and Characteristics:

2. Full-Load Efficiency:
   a. COP: <Insert number>.
   b. EER: <Insert number>.
   c. Power Input/Cooling Output, kW/ton: <Insert value>.

3. Part-Load Efficiency:
   a. IPLV: <Insert number>.

4. Evaporator Type: Brazed plate or Shell and tube.
5. Evaporator Pressure Rating: <Insert psig>.
6. Evaporator Fluid Type: Water <Insert fluid type>.
11. Evaporator Fluid Pressure Drop: <Insert feet of head>.
12. Evaporator Fouling Factor 0.00025 sq. ft. x h x deg F/Btu.
13. Condenser Type: Shell and tube.
15. Condenser Fluid Type: Water <Insert fluid type>.
Reciprocating Water Chillers

20. Condenser Fouling Factor 0.0005 sq. ft. x h x deg F/Btu.
22. Compressor Rated Load Amperes: <Insert value>.
23. Compressor Locked-Rotor Amperes: <Insert value>.
   b. Controls Minimum Circuit Ampacity: <Insert value>.
   c. Controls Maximum Overcurrent Protection Device: <Insert amperage>.
   d. Controls Electrical Characteristics: 120 <Insert value>-V ac, single three phase, 60 Hz.
28. Chiller Electrical Characteristics: 208 240 480 600 <Insert value>-V ac, three phase, 60 Hz.
29. Noise Rating: <Insert dBA> at <Insert distance in feet> when measured according to ARI 575.

2.2 PACKAGED AIR-COOLED WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a United Technologies company.
   2. Trane
   3. McQuay
   4. York
B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.

D. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit. Base shall be designed to limit deflection to L/200 and shall be a minimum of 4 inches high.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
5. Sound-reduction package consisting of the following:
   a. Acoustic enclosure around compressors.
   b. Reduced-speed fans with acoustic treatment.
   c. Designed to reduce sound level without affecting performance.
6. Security Package: Provide security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.

E. Compressors:

1. Description: Positive-displacement direct drive with semi-hermetically sealed and accessible bolted casings.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: 1750 rpm for 60-Hz applications.
4. Capacity Control: Combinations of cylinder unloading and on-off compressor cycling of multiple compressors plus hot-gas bypass. Compressor shall be capable of operating at part-load conditions without increased vibration over normal vibration at
full-load operation and shall be capable of continuous operation at its lowest step of
unloading.
5. Oil Lubrication System: Automatically reversible, positive-displacement pump with
strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
6. Vibration Isolation: Mount individual compressors on spring isolators with an isolation
efficiency of 95 percent.

F. Compressor Motors:
1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, four-pole induction type with inherent thermal-overload protection on each
phase.

G. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.
2. Part-Wind Start: NEMA ICS 2, Class A, reduced voltage, nonreversing.

H. Refrigeration:
1. Refrigerant: R-22. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with
refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal an electronic expansion valve,
refrigerant charging connections, a hot-gas muffler, compressor suction and discharge
shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass
with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor
discharge line and the refrigerant liquid-line to allow the isolation and storage of the
refrigerant charge in the chiller condenser.

I. Evaporator:
1. Description: Direct-expansion shell-and-tube design with fluid flowing through the shell
and refrigerant flowing through the tubes within the shell.
2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure
Vessel Code.
4. Shell Heads: Removable carbon-steel heads with multi-pass baffles designed to ensure
positive oil return and located at each end of the tube bundle.
5. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with flanged end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
7. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.

J. Air-Cooled Condenser:
1. Plate-fin coil with integral sub-cooling circuit, leak tested at 150 psig.
   a. Construct coils of copper tubes mechanically bonded to aluminum fins.
2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

K. Electrical Power:
1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250 Type 4 enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to wire lugs NEMA KS 1, heavy-duty, non-fused disconnect switch.
6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   b. NEMA KS 1, heavy-duty, non-fusible switch.
c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
10. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
   a. Power unit-mounted controls where indicated.
   b. Power unit-mounted, ground-fault interrupt (GFI) duplex receptacle.

11. Control Relays: Auxiliary and adjustable time-delay relays.
12. Indicate the following for water chiller electrical power supply:
   a. Current, phase to phase, for all three phases.
   b. Voltage, phase to phase and phase to neutral for all three phases.
   c. Three-phase real power (kilowatts).
   d. Three-phase reactive power (kilovolt amperes reactive).
   e. Power factor.
   f. Running log of total power versus time (kilowatt hours).
   g. Fault log, with time and date of each.

I. Controls:

1. Stand-alone, microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
   a. Date and time.
   b. Operating or alarm status.
   c. Operating hours.
   d. Outside-air temperature if required for chilled-water reset.
   e. Temperature and pressure of operating set points.
   f. Entering and leaving temperatures of chilled water.
   g. Refrigerant pressures in evaporator and condenser.
   h. Saturation temperature in evaporator and condenser.
i. No cooling load condition.

j. Elapsed time meter (compressor run status).

k. Pump status.

l. Anti-recycling timer status.

m. Percent of maximum motor amperage.

n. Current-limit set point.

o. Number of compressor starts.

4. Control Functions:

a. Manual or automatic startup and shutdown time schedule.

b. Entering and leaving chilled-water temperature, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water temperature.

c. Current limit and demand limit.

d. External water chiller emergency stop.

e. Anti-recycling timer.

f. Automatic lead-lag switching.

5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

a. Low evaporator pressure or high condenser pressure.

b. Low chilled-water temperature.

c. Refrigerant high pressure.

d. High or low oil pressure.

e. High oil temperature.

f. Loss of chilled-water flow.

g. Control device failure.

6. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display water chiller status and alarms.

a. ASHRAE 135 BacNet or LonTalk Industry-accepted open-protocol communication interface with building management system shall enable building management system operator to control and monitor the water chiller from a remote operator workstation. Control features and monitoring points displayed
locally at water chiller control panel shall be available through building management system.

M. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
2. Thickness: 1 inch Factory-applied insulation over cold surfaces of water chiller components.
   a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
3. Apply protective coating to exposed surfaces of insulation.

N. Accessories:

1. Factory-furnished, chilled-and condenser water flow switches for field installation.
2. Individual compressor suction and discharge pressure gauges with shutoff valves.
3. Factory-furnished spring isolators for field installation.

O. Capacities and Characteristics:

2. Full-Load Efficiency:
   a. COP: <Insert number>.
   b. EER: <Insert number>.
   c. Power Input/Cooling Output, kW/ton: <Insert value>.
3. Part-Load Efficiency:
   a. IPLV: <Insert number>.

4. Low Ambient Operation: Chiller designed for operation to minus 20 deg F.
5. High Ambient Operation: Chiller designed for operation to 115 deg F.
7. Evaporator Fluid Type: Water <Insert fluid type>.
12. Evaporator Fluid Pressure Drop: <Insert feet of head>.
13. Evaporator Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu Condenser Entering-Air Temperature: <Insert deg F>.
15. Condenser Fan External Static Pressure: 1.0-inch wg.
17. Compressor Rated Load Amperes: <Insert value>.
   b. Controls Minimum Circuit Ampacity: <Insert value>.
   c. Controls Maximum Overcurrent Protection Device: <Insert amperage>.
   d. Controls Electrical Characteristics: 120-V ac, single phase, 60 Hz.
23. Chiller Electrical Characteristics: 208 240 480 600 <Insert value>-V ac, three phase, 60 Hz.
24. Noise Rating: <Insert dBA> at <Insert distance in feet> when measured according to ARI 370.

2.3 PACKAGED REFRIGERANT RECOVERY UNITS

A. Packaged portable unit shall consist of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valves that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest water chiller.

2.4 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.
1. Allow Owner access to place where water chillers are being tested. Notify Architect 14 days in advance of testing.

B. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

C. For water chillers located indoors, rate sound power level according to ARI 575 procedure.

D. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

END OF SECTION 236419
SCROLL WATER CHILLERS
SECTION 236423 - SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged, water-cooled, electric-motor-driven, scroll water chillers.
   2. Packaged, air-cooled, electric-motor-driven, scroll water chillers.
   3. Packaged refrigerant recovery units.

1.2 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 590 certification program.

B. ARI Rating: Rate water chiller performance according to requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

C. ASHRAE Compliance:
   1. ASHRAE 15 for safety code for mechanical refrigeration.
   2. ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
   3. ASHRAE/IESNA 90.1 for energy efficiency.

D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 70.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittals:
1. Product Data for Credit EA 4: For refrigerants, indicating printed statement that refrigerants are free of HCFCs.

C. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
   1. Assembled unit dimensions.
   2. Weight and load distribution.
   3. Required clearances for maintenance and operation.
   4. Size and location of piping and wiring connections.
   5. Wiring Diagrams: For power, signal, and control wiring.

D. Certificates: For certification required in "Quality Assurance" Article.

E. Seismic Qualification Certificates: For water chillers, accessories, and components from manufacturers.

F. Factory quality-control and test reports.

G. Startup service reports.

H. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

I. Warranty: Sample of special warranty.

PART 2 -

2.1 PACKAGED WATER-COOLED WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier
   2. Trane.
   3. York
   4. McQuay

B. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.
C. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

D. Compressors:
   1. Description: Positive-displacement direct drive with hermetically sealed casing.
   2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
   3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
   5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
   7. Sound-reduction package shall consist of acoustic enclosures around the compressors that are designed to reduce sound level without affecting performance.

E. Compressor Motors:
   1. Hermetically sealed and cooled by refrigerant suction gas.
   2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

F. Compressor Motor Controllers:
   1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

G. Refrigeration:
   1. Refrigerant: R-410A
   2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
   4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

H. Evaporator:
   1. Shell and Tube:
a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
c. Shell Material: Carbon steel.
d. Shell Heads: Removable carbon-steel heads with multi-pass baffles designed to ensure positive oil return and located at each end of the tube bundle.
e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with flanged end connections for connection to field piping.
f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

2. Brazed Plate:

a. Direct-expansion, single-pass, brazed-plate design.
b. Type 316 stainless-steel construction.
c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
d. Fluid Nozzles: Terminate with flanged end connections for connection to field piping.

I. Condenser:

1. Shell and tube or without integral condenser; as indicated.

2. Shell and Tube:

a. Description: Shell-and-tube design with refrigerant flowing through the shell and fluid flowing through the tubes within the shell.
b. Provides positive sub-cooling of liquid refrigerant.
c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
e. Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with flanged end connections for connection to field piping.
f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
g. Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.
3. Provide water chiller without an integral condenser and design chiller for field connection to remote condenser. Coordinate requirements with Division 23 Section "Air-Cooled Refrigerant Condensers."

J. Electrical Power:

1. Factory-installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250, Type 1 enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to wire lugs NEMA KS 1, heavy-duty, non-fused disconnect switch.
6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   b. NEMA KS 1, heavy-duty, non-fusible switch.
   c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
10. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
11. Control Relays: Auxiliary and adjustable time-delay relays.
12. Indicate the following for water chiller electrical power supply:
   a. Current, phase to phase, for all three phases.
   b. Voltage, phase to phase and phase to neutral for all three phases.
   c. Three-phase real power (kilowatts).
   d. Three-phase reactive power (kilovolt amperes reactive).
   e. Power factor.
   f. Running log of total power versus time (kilowatt hours).
g. Fault log, with time and date of each.

K. Controls:

1. Stand-alone, microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:
   a. Date and time.
   b. Operating or alarm status.
   c. Operating hours.
   d. Outside-air temperature if required for chilled-water reset.
   e. Temperature and pressure of operating set points.
   f. Entering and leaving temperatures of chilled water.
   g. Entering and leaving temperatures of condenser water.
   h. Refrigerant pressures in evaporator and condenser.
   i. Saturation temperature in evaporator and condenser.
   j. No cooling load condition.
   k. Elapsed time meter (compressor run status).
   l. Pump status.
   m. Antirecycling timer status.
   n. Percent of maximum motor amperage.
   o. Current-limit set point.
   p. Number of compressor starts.

4. Control Functions:
   a. Manual or automatic startup and shutdown time schedule.
   b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water outside-air space temperature.
   c. Current limit and demand limit.
   d. Condenser-water temperature.
   e. External water chiller emergency stop.
   f. Anti-recycling timer.
   g. Automatic lead-lag switching.
5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
   a. Low evaporator pressure or high condenser pressure.
   b. Low chilled-water temperature.
   c. Refrigerant high pressure.
   d. High or low oil pressure.
   e. High oil temperature.
   f. Loss of chilled-water flow.
   g. Loss of condenser-water flow.
   h. Control device failure.

6. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display water chiller status and alarms.
   a. ASHRAE 135 BacNet or LonTalk Industry-accepted open-protocol communication interface with building management system shall enable building management system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building management system.

L. Insulation:
   1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
   2. Thickness: 1 inch
   3. Factory-applied insulation over cold surfaces of water chiller components.
      a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
   4. Apply protective coating to exposed surfaces of insulation.

M. Accessories:
   1. Factory-furnished, chilled- and condenser-water flow switches for field installation.
   2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
   3. Factory-furnished neoprene spring isolators for field installation.
N. Capacities and Characteristics:

2. Full-Load Efficiency:
   a. COP: <Insert number>.
   b. EER: <Insert number>.
   c. Power Input/Cooling Output, kW/Ton: <Insert value>.
3. Part-Load Efficiency:
   a. IPLV: <Insert number>.
4. Evaporator Type: Brazed plate or shell and tube.
5. Evaporator Pressure Rating: <Insert psig>.
6. Evaporator Fluid Type: Water <Insert fluid type>.
11. Evaporator Fluid Pressure Drop: <Insert feet of head>.
12. Evaporator Fouling Factor 0.00025 sq. ft. x h x deg F/Btu
13. Condenser Type: Shell and tube
15. Condenser Fluid Type: Water <Insert fluid type>.
19. Condenser Fluid Pressure Drop: <Insert feet of head>
20. Condenser Fouling Factor: 0.001 sq. ft. x h x deg F/Btu
22. Compressor Rated Load Amperes: <Insert value>.
23. Compressor Locked-Rotor Amperes: <Insert value>.
28. Chiller Electrical Characteristics: 208 240 480 600 <Insert value>-V ac, three phase, 60 Hz.
29. Noise Rating: \(<\text{Insert dBA}>\) at \(<\text{Insert distance in feet}>,\) when measured according to ARI 575.

2.2 PACKAGED AIR-COOLED WATER CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
   1. Carrier Corporation; a United Technologies company.
   2. Trane.
   4. McQuay

B. Description: Factory-assembled and run-tested water chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Fabricate base, frame, and attachment to water chiller components strong enough to resist movement during a seismic event when water chiller base is anchored to field support structure.

D. Cabinet:
   
   1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
   2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
   4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
   5. Sound-reduction package consisting of the following:
      
      a. Acoustic enclosure around compressors.
      b. Reduced-speed fans with acoustic treatment.
      c. Designed to reduce sound level without affecting performance.

   6. Security Package: Provide security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.
E. Compressors:

1. Description: Positive-displacement direct drive with hermetically sealed casing.
2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.

F. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

G. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

H. Refrigeration:

1. Refrigerant: R-407c or R-410a. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each circuit shall include a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.

I. Evaporator:

1. Brazed-plate or shell-and-tube design, as indicated.
2. Shell and Tube:
a. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
b. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
c. Shell Material: Carbon steel.
d. Shell Heads: Removable carbon-steel heads with multi-pass baffles designed to ensure positive oil return and located at each end of the tube bundle.
e. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with flanged end connections for connection to field piping.
f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

3. Brazed Plate:

a. Direct-expansion, single-pass, brazed-plate design.
b. Type 316 stainless-steel construction.
c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
d. Fluid Nozzles: Terminate with flanged end connections for connection to field piping.

4. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.

5. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

J. Air-Cooled Condenser:

1. Plate-fin coil with integral sub-cooling on each circuit, rated at 450 psig.

   a. Construct coils of copper tubes mechanically bonded to aluminum with precoated epoxy-phenolic fins.
   b. Coat coils with a baked epoxy corrosion-resistant coating after fabrication.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

3. Fan Motors: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

4. Fan Guards: Steel safety guards with corrosion-resistant coating.
K. Electrical Power:

1. Factory-installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field power interface shall be to wire lugs NEMA KS 1, heavy-duty, non-fused disconnect switch.
6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   b. NEMA KS 1, heavy-duty, non-fusible switch.
   c. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
10. Provide power factor correction capacitors to correct power factor to 0.95 value at full load.
11. Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
   a. Power unit-mounted controls where indicated.
   b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.
13. Indicate the following for water chiller electrical power supply:
   a. Current, phase to phase, for all three phases.
   b. Voltage, phase to phase and phase to neutral for all three phases.
   c. Three-phase real power (kilowatts).
   d. Three-phase reactive power (kilovolt amperes reactive).
e. Power factor.
f. Running log of total power versus time (kilowatt hours).
g. Fault log, with time and date of each.

1. Controls:

   1. Stand-alone, microprocessor based.
   2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
   3. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, backlit, liquid-crystal display or light-emitting diodes. Display the following:

      a. Date and time.
      b. Operating or alarm status.
      c. Operating hours.
      d. Outside-air temperature if required for chilled-water reset.
      e. Temperature and pressure of operating set points.
      f. Entering and leaving temperatures of chilled water.
      g. Refrigerant pressures in evaporator and condenser.
      h. Saturation temperature in evaporator and condenser.
      i. No cooling load condition.
      j. Elapsed time meter (compressor run status).
      k. Pump status.
      l. Anti-recycling timer status.
      m. Percent of maximum motor amperage.
      n. Current-limit set point.
      o. Number of compressor start

4. Control Functions:

   a. Manual or automatic startup and shutdown time schedule.
   b. Entering and leaving chilled-water temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on return-water outside-air space temperature.
   c. Current limit and demand limit.
   d. External water chiller emergency stop.
   e. Anti-recycling timer.
   f. Automatic lead-lag switching.
5. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

   a. Low evaporator pressure or high condenser pressure.
   b. Low chilled-water temperature.
   c. Refrigerant high pressure.
   d. High or low oil pressure.
   e. High oil temperature.
   f. Loss of chilled-water flow.
   g. Control device failure.

6. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor, control, and display water chiller status and alarms.

   a. ASHRAE 135 BacNet or LonTalk Industry-accepted open-protocol <Insert type of interface> communication interface with building management system shall enable building management system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through building management system.

M. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I, for tubular materials and Type II, for sheet materials.
2. Thickness 1-1/2 inches
3. Factory-applied insulation over cold surfaces of water chiller components.

   a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

4. Apply protective coating to exposed surfaces of insulation.

N. Accessories:

1. Factory-furnished, chilled-and condenser water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigeration circuit.
3. Factory-furnished neoprene or spring isolators for field installation.
O. Capacities and Characteristics:

2. Full-Load Efficiency:
   a. COP: <Insert number>.
   b. EER: <Insert number>.
   c. Power Input/Cooling Output, kW/Ton: <Insert value>.
3. Part-Load Efficiency:
   a. IPLV: <Insert number>.
4. Low Ambient Operation: Chiller designed for operation to 0 deg F
5. High Ambient Operation: Chiller designed for operation to 115 deg F
6. Evaporator Configuration: Integral to chiller
7. Evaporator Pressure Rating: 150 psig 300 psig <Insert value>.
8. Evaporator Fluid Type: Water
14. Evaporator Fouling Factor: 0.00025 sq. ft. x h x deg F/Btu
16. Site Altitude: <Insert feet>.
17. Number of Refrigeration Circuits: One Two.
18. Compressor Rated Load Amperes: <Insert value>.
   b. Controls Minimum Circuit Ampacity: <Insert value>.
   c. Controls Maximum Overcurrent Protection Device: <Insert amperage>.
   d. Controls Electrical Characteristics: 120 V ac, single phase, 60 Hz.
24. Chiller Electrical Characteristics: 208 240 480 600 V ac, three phase, 60 Hz.
25. Noise Rating: <Insert dBA> at <Insert distance in feet> when measured according to ARI 370.

2.3 PACKAGED REFRIGERANT RECOVERY UNITS

A. Packaged portable unit shall consist of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valves that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and -stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest water chiller.

2.4 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.
B. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
C. For water chillers located indoors, rate sound power level according to ARI 575 procedure.
D. For water chillers located outdoors, rate sound power level according to ARI 370 procedure.

END OF SECTION 236423
ROTARY-SCREW WATER CHILLERS
SECTION 236426 - ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Packaged, water-cooled, single-compressor chillers.
   2. Packaged, water-cooled, multiple-compressor chillers.
   3. Packaged, air-cooled chillers.
   4. Packaged, portable refrigerant recovery units.
   5. Heat-exchanger, brush-cleaning system.

1.2 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 and ARI 590 certification program(s).
B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.
C. ASHRAE Compliance:
   1. ASHRAE 15 for safety code for mechanical refrigeration.
   2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1
E. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.
F. Comply with NFPA 70.
G. Comply with requirements of UL and UL Canada and include label by a qualified testing agency showing compliance.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittal:
   1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

D. Certificates: For certification required in "Quality Assurance" Article.

E. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

F. Factory quality-control and test reports.

G. Startup service reports.

H. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

I. Warranty: Sample of special warranty.

PART 2 - PRODUCTS

2.1 PACKAGED, WATER-COOLED, SINGLE-COMPRESSOR CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a United Technologies company.
   2. YORK International Corporation.
3. Trane
4. McQuay

B. Description: Factory-assembled and run-tested chiller with compressor, compressor motor, compressor motor controller, lubrication system, evaporator, condenser, heat-reclaim condenser as indicated, controls, interconnecting unit piping and wiring, and indicated accessories.

1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

C. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

D. Compressor:

1. Description: Hermetic or open positive displacement, and oil lubricated.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one-, two-, or three-rotor design.
4. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
5. Seals: Seal drive assembly to prevent refrigerant leakage.

E. Compressor Motor:

1. Continuous-duty, squirrel-cage, induction-type motor with energy efficiency required to suit chiller energy efficiency indicated.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. For chillers with open drives, provide motor with totally enclosed enclosure.
5. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.
6. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
7. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.
F. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.

1. Over speed Test: 25 percent above design operating speed.

G. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

H. Capacity Control: Modulating slide-valve assembly or port unloaders combined with a variable frequency controller, if applicable, and hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 10 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature Drop-in entering condenser-fluid temperature of 2.5 deg F drop for each 10 percent in capacity reduction

I. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Dual oil filters, one redundant, shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
4. Refrigerant- or water-cooled oil cooler.
5. Factory-installed and pressure-tested piping with isolation valves and accessories.
6. Oil compatible with refrigerant and chiller components.
7. Positive visual indication of oil level.

J. Refrigerant Circuit:

1. Refrigerant: Type as indicated on Drawings.
2. Refrigerant Type: R-134a. Classified as Safety Group A1 according to ASHRAE 34.
3. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

4. Refrigerant Flow Control: Manufacturer’s standard refrigerant flow-control device satisfying performance requirements indicated.

5. Pressure Relief Device:
   a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

6. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

7. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

K. Evaporator:

1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser.

2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

3. Designed to prevent liquid refrigerant carryover from entering compressor.

4. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

5. Tubes:
   a. Individually replaceable from either end and without damage to tube sheets and other tubes.
   b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
c. Material: Copper Retain one of four options in first subparagraph below. First and fourth options give manufacturer the choice. Second option limits size available from listed manufacturers. Only Trane offers third option.

d. Nominal OD: 3/4 or 1 inch.

e. Minimum Wall Thickness: 0.035 inch

f. External Finish: Manufacturer’s standard.

g. Internal Finish: Enhanced or smooth.

6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

8. Water Box:

   a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

   b. Marine type for water box with piping connections. Standard type for water box without piping connections.

   c. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.

   d. Hinged or davited marine water-box covers.

   e. Nozzle Pipe Connections Welded, ASME B16.5, raised-face flange.

   f. Thermistor or RTD temperature sensor factory installed in each nozzle.

   g. Fit each water box with 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

9. Additional Corrosion Protection:

   a. Coat wetted surfaces with a corrosion-resistant finish.

I. Condenser:

   1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

   2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

   3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

   4. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.

   5. Tubes:
a. Individually replaceable from either end and without damage to tube sheets and other tubes.
b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
c. Material: Copper Retain one of four options in first subparagraph below. First and fourth options give manufacturer the choice. Second option limits size available from listed manufacturers. Only Trane offers third option.
d. Nominal OD 3/4 or 1 inch.
e. Minimum Wall Thickness 0.035 inch
f. External Finish: Manufacturer’s standard.
g. Internal Finish Enhanced or smooth.

6. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

7. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

8. Water Box:

a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
b. Marine type for water box with piping connections. Standard type for water box without piping connections.
c. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
d. Hinged or davited marine water-box covers.
e. Nozzle Pipe Connections Welded, ASME B16.5, raised-face flange.
f. Thermistor or RTD temperature sensor factory installed in each nozzle.
g. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

9. Additional Corrosion Protection:
a. Coat wetted surfaces with a corrosion-resistant finish.

M. Heat-Reclaim Condenser:

1. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator and condenser.
2. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.
3. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

4. Tubes:
   a. Individually replaceable from either end and without damage to tube sheets and other tubes.
   b. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
   c. Material: Copper Retain one of four options in first subparagraph below. First and fourth options give manufacturer the choice. Second option limits size available from listed manufacturers. Only Trane offers third option.
   d. Nominal OD: 3/4 or 1 inch.
   e. Minimum Wall Thickness 0.035 inch
   f. External Finish: Manufacturer’s standard.
   g. Internal Finish: Enhanced or smooth.

5. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

6. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

7. Water Box:
   a. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
   b. Marine type for water box with piping connections. Standard type for water box without piping connections.
   c. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.
   d. Hinged or davited marine water-box covers.
   e. Nozzle Pipe Connections Welded, ASME B16.5, raised-face flange.
   f. Thermistor or RTD temperature sensor factory installed in each nozzle.
   g. Fit each water box with 3/4- or 1-inch drain connection at low point and vent connection at high point, each with threaded plug.

8. Additional Corrosion Protection:
   a. Coat wetted surfaces with a corrosion-resistant finish.

N. Electrical Power:

1. Factory installed and wired, and functionally tested at factory before shipment.
2. Single-point, field-power connection to circuit breaker. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
   a. Provide branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.
   b. NEMA- and ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
   c. Control-circuit transformer with primary and secondary side fuses.

3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

4. Factory-installed wiring outside of enclosures shall be in metal raceway except make connections to each motor and heater with not more than a 24-inch length of liquid-tight conduit.

5. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95 at all operating conditions.
   a. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
   b. Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAR ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.
   c. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within 1 minute after de-energizing.
   d. Provide a ground terminal and a terminal block or individual connectors for phase connection.

O. Motor Controller:
   1. Enclosure: Factory installed, unit mounted NEMA 250 or NEMA ICS 6 Type 12 with hinged full-front access door with lock and key or padlock and key.
   2. Control Circuit: Obtained from integral control power transformer of control with a control power transformer of enough capacity to operate connected control devices.
   3. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.
a. Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

b. Visual indication of motor and control status, including the following conditions:
   1) Controller on.
   2) Overload trip.
   3) Loss of phase.
   4) Starter fault.

5. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

   a. Externally Operated Door-Interlocked Disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.
   c. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
   d. Control Relays: Time-delay relays.
   e. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
   f. Number-of-Starts Counter: Numerical readout on face of enclosure.
   g. Meters: Panel type, 2-1/2 inches with 90 120 270-degree scale and 1 percent accuracy. Where indicated, provide transfer device with an off position. Meters shall indicate the following:
      1) Ammeter: Output current for each phase, with current sensors rated to suit application.
      2) Voltmeter: Output voltage for each phase.
      3) Frequency Meter: Output frequency.
      4) Real-time clock with current time and date.
      5) Total run time.
   h. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
      1) Selectable, digital display of the following:
a) Phase Currents, Each Phase: Plus or minus 1 percent.
b) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d) Three-Phase Real Power: Plus or minus 2 percent.
e) Three-Phase Reactive Power: Plus or minus 2 percent.
f) Power Factor: Plus or minus 2 percent.
g) Frequency: Plus or minus 0.5 percent.
h) Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i) Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

2) Mounting: Display and control unit flush or semi-recessed in instrument compartment door.

i. Phase-Failure, Phase-Reversal, Under-voltage Relays: Solid-state sensing circuit with adjustable under-voltage setting and isolated output contacts for hardwired connection.
j. Power Protection: Chiller shall shut down within six cycles of power interruption.

P. Variable Frequency Controller:

1. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
2. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
3. Enclosure: Unit mounted, NEMA 250, Type 1 with hinged full-front access door with lock and key.
4. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 100,000 A.
5. Technology: Pulse width modulated PWM output suitable for constant or variable torque loads.
6. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
7. Operating Requirements:
   a. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum
   b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
c. Capable of driving full load, without derating, under the following conditions:
   
   1) Ambient Temperature: 0 to 40 deg C.
   2) Relative Humidity: Up to 90 percent noncondensing.

d. Minimum Efficiency: 96 percent at 60 Hz, full load.
e. Minimum Displacement Primary-Side Power Factor: 98 percent.
f. Overload Capability: 1.05 times the full-load current for 7 seconds.
g. Starting Torque: As required by compressor-drive assembly.
h. Speed Regulation: Plus or minus 1 percent.
i. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
j. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

8. Internal Adjustability Capabilities:

a. Minimum Output Frequency: 6 Hz.
b. Maximum Output Frequency: 60 Hz.
c. Acceleration: 2 seconds to 60 seconds.
d. Deceleration: Zero seconds to 60 seconds.
e. Current Limit: 30 to a minimum of 100 percent of maximum rating.

9. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

a. Over-temperature.
b. Short circuit at controller output.
c. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
d. Open circuit at controller output.
e. Input under-voltage.
f. Input overvoltage.
g. Loss of input-phase.
h. Reverse phase.
i. AC line switching transients.
j. Instantaneous overload, line to line or line to ground.
k. Sustained overload exceeding 100 percent of controller rated current.
l. Starting a rotating motor.

10. Motor Protection: Controller shall protect motor against overvoltage, phase loss, reverse phase, overcurrent, over-temperature, and ground fault.

11. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss, and overvoltage and undervoltage trips.

12. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.
g. Motor speed (percent).
h. Fault or alarm status (code).
i. Motor output voltage.
j. Input kilovolt amperes.
k. Total power factor.
l. Input kilowatts.
m. Input kilowatt-hours.
n. Three-phase input voltage.
o. Three-phase output voltage.
p. Three-phase input current.
q. Three-phase output current.
r. Output frequency (Hertz).
s. Elapsed operating time (hours).
t. Diagnostic and service parameters.

13. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

14. Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 5 percent.

Q. Controls:
1. Standalone and microprocessor based with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

2. Enclosure: Unit mounted, NEMA 250, Type 12 hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:
   a. Operating or alarm status.
   b. Fault history with not less than last 10 faults displayed.
   c. Set points of controllable parameters.
   d. Trend data.
   e. Operating hours.
   f. Number of chiller starts.
   g. Outdoor-air temperature or space temperature if required for chilled-water reset.
   h. Temperature and pressure of operating set points.
   i. Entering- and leaving-fluid temperatures of evaporator and condenser.
   j. Difference in fluid temperatures of evaporator and condenser.
   k. Fluid flow of evaporator and condenser.
   l. Fluid pressure drop of evaporator and condenser.
   m. Refrigerant pressures in evaporator and condenser.
   n. Refrigerant saturation temperature in evaporator and condenser.
   o. Pump status.
   p. Anti-recycling timer status.
   q. Percent of maximum motor amperage.
   r. Current-limit set point.
   s. Compressor bearing temperature.
   t. Motor bearing temperature.
   u. Motor winding temperature.
   v. Oil temperature.
   w. Oil discharge pressure.
   x. Phase current.
   y. Percent of motor rated load amperes.
   z. Phase voltage.
   aa. Demand power (kilowatts).
   bb. Energy use (kilowatt-hours).
   cc. Power factor.

4. Control Functions:
   a. Manual or automatic startup and shutdown time schedule.
b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on return-water temperature.

c. Current limit and demand limit.

d. Condenser-fluid temperature.

e. External chiller emergency stop.

f. Anti-recycling timer.

g. Variable evaporator flow.

h. Thermal storage.

i. Heat reclaim.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

a. Low evaporator pressure or temperature; high condenser pressure.

b. Low evaporator fluid temperature.

c. Low oil differential pressure.

d. High or low oil pressure.

e. High oil temperature.

f. High compressor-discharge temperature.

g. Loss of condenser-fluid flow.

h. Loss of evaporator-fluid flow.

i. Motor overcurrent.

j. Motor overvoltage.

k. Motor undervoltage.

l. Motor phase reversal.

m. Motor phase failure.

n. Sensor- or detection-circuit fault.

o. Processor communication loss.

p. Motor controller fault.

q. Extended compressor surge.

r. manually reset safety controls.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
9. Communication Port: RS-232 port or equivalent connection capable of connecting a printer and a notebook computer.

10. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
   a. ASHRAE 135 BacNet or LonTalk, or ModBus Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

R. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 1-1/2 inches
3. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. Factory-applied insulation over cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
   a. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
   b. Seal seams and joints to provide a vapor barrier.
   c. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

S. Finish:

1. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:
   a. Provide at least one coat of primer with a total dry film thickness of at least 2 mils.
   b. Provide at least two coats of alkyd-modified, vinyl enamel finish with a total dry film thickness of at least 4 mils.
c. Paint surfaces that are to be insulated before applying the insulation.
d. Paint installed insulation to match adjacent un-insulated surfaces.
e. Color of finish coat to be manufacturer’s standard

2. Provide Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

T. Accessories:

a. If required and not factory installed, chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.

b. Pressure Differential Switches:

1) Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
2) Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
3) Set Point: Screw type, field adjustable.
4) Electrical Connections: Internally mounted screw-type terminal blocks.
5) Switch Enclosure: NEMA 250, Type 4
6) Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

2. Vibration Isolation:

a. Chiller manufacturer shall furnish vibration isolation for each chiller.

b. Neoprene Pad:

1) Two layers of 0.375-inch thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
2) Fabricate pads from 40- to 50-durometer neoprene.
3) Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

c. Spring Isolator:
1) Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions. Isolators shall be designed such that the Kx/Ky ratio shall be 1.0 or more for stability.

2) Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Aluminum components shall be etched and painted. Nuts, bolts, and washers shall be zinc electroplated.

3) Isolators shall be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate. An elastomeric pad with a minimum thickness of 0.25 inch shall be bonded to the baseplate.

4) Spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts shall not be engaged during normal operation and shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.

5) Isolators shall be selected for a nominal 2-inch deflection.

3. Sound Barrier:

   a. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.
   
   b. Provide for repeated installation and removal without use of tape or calk.
   
   c. Inner and outer cover shall consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.
   
   d. Covers shall be double sewn and lock stitched with edges folded and sewn so no raw cut edges are exposed.
   
   e. Form covers around control devices, gages, conduit, piping, and supports without degrading sound-barrier performance.
   
   f. Continuously lap all exposed seams at least 2 inches for better sound containment.
   
   g. Permanently label each section of cover to indicate its location, description, size, and number sequence.
   
   h. Randomly place stainless-steel quilting pins to prevent covers from shifting and sagging.

U. Capacities and Characteristics:
2. Full-Load Efficiency (COP): Insert value.
3. Full-Load Efficiency (EER): Insert value.
5. Part-Load Efficiency (IPLV): Insert value.
7. Evaporator:
   b. Number of Passes: One Two Three.
   c. Fluid Type: Water Insert fluid type.
   d. Design Fluid Flow Rate: Insert gpm.
   e. Minimum Fluid Flow Rate: Insert gpm.
   f. Entering-Fluid Temperature: Insert deg F.
   g. Leaving-Fluid Temperature: Insert deg F.
   h. Fluid Pressure Drop: Insert feet of head.
   i. Fluid Velocity: Insert fps.
   j. Fouling Factor 0.0005 sq. ft. x h x deg F/Btu Insert value.
8. Condenser:
   b. Number of Passes: One Two Three.
   c. Fluid Type: Water Insert fluid type.
   d. Design Fluid Flow Rate: Insert gpm.
   e. Entering-Fluid Temperature: Insert deg F.
   f. Leaving-Fluid Temperature: Insert deg F.
   g. Fluid Pressure Drop: Insert feet of head.
   h. Fluid Velocity: Insert fps.
   i. Fouling Factor 0.001 sq. ft. x h x deg F/Btu Insert value.
9. Heat-Reclaim Condenser:
   b. Number of Passes: One Two Three.
   c. Fluid Type: Water Insert fluid type.
   d. Design Fluid Flow Rate: Insert gpm.
   e. Entering-Fluid Temperature: Insert deg F.
   f. Leaving-Fluid Temperature: Insert deg F.
   g. Fluid Pressure Drop: Insert feet of head.
h. Fluid Velocity: <Insert fps>.

i. Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu <Insert value>.

10. Compressor:

   a. Rated Load Amperes: <Insert value>.
   b. Locked-Rotor Amperes: <Insert value>.

11. Chiller Electrical Requirements:

   b. Power Factor: 0.90 0.95 <Insert value>.
   c. Minimum Circuit Ampacity: <Insert value>.
   d. Maximum Overcurrent Protection Device: <Insert amperage>.
   e. Volts: 208 240 480 600 2300 4160 <Insert value>.
   f. Phase: Three.
   g. Hertz: 60.

12. Noise Rating: 85 dBA sound power level when measured according to ARI 575. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

2.2 PACKAGED, WATER-COOLED, MULTIPLE-COMPRESSOR CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a United Technologies company.
2. YORK International Corporation.

B. Description: Factory-assembled and run-tested chiller with compressor(s), compressor motors and motor controllers, evaporator, condenser where indicated, electrical power, controls, and indicated accessories.

1. Disassemble chiller into major assemblies as required by the installation after factory testing and before packaging for shipment.

C. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.
D. Compressors:
   1. Description: Positive displacement, hermetically sealed.
   2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
   3. Rotors: Manufacturer's standard one- or two-rotor design.

E. Service: Easily accessible for inspection and service.
   1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
   2. Provide lifting lugs or eyebolts attached to casing.

F. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.
   1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
   2. Operating Range: From 100 to 10 percent of design capacity.
   3. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 deg F for each 10 percent in capacity reduction

G. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.
   1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
   2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
   3. Factory-installed and pressure-tested piping with isolation valves and accessories.
   4. Oil compatible with refrigerant and chiller components.
   5. Positive visual indication of oil level.

H. Vibration Control:
   1. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.
      a. Over speed Test: 25 percent above design operating speed.
   2. Isolation: Mount individual compressors on vibration isolators.
I. Sound Control: Sound-reduction package shall consist of removable acoustic enclosures around the compressors and drive assemblies that are designed to reduce sound levels without affecting performance.

J. Compressor Motors:
   1. Hermetically sealed and cooled by refrigerant suction gas.
   2. High-torque, induction type with inherent thermal-overload protection on each phase.

K. Refrigerant Circuits:
   1. Refrigerant Type: R-134a. Classified as Safety Group A1 according to ASHRAE 34.
   2. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   3. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
   4. Pressure Relief Device:
      a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.
   5. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line to the condenser and the refrigerant liquid-line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell.

L. Evaporator:
   1. Description: Shell-and-tube design.
      a. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
   2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   4. Shell Heads: Removable carbon-steel heads with multipass baffles, and located at each end of the tube bundle.
5. Fluid Nozzles: Terminated with flanged end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.

M. Condenser:
1. Shell and Tube:
   a. Description: Shell-and-tube design with refrigerant flowing through shell, and fluid flowing through tubes within shell.
   b. Provides positive sub-cooling of liquid refrigerant.
   c. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   e. Water Boxes: Removable, of carbon-steel construction, located at each end of the tube bundle with fluid nozzles terminated with flanged end connections for connection to field piping.
   f. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
   g. Provide each condenser with a pressure relief device, purge cock, and liquid-line shutoff valve.

2. Provide chiller without an integral condenser and design chiller for field connection to remote condenser. Coordinate requirements with Division 23 Section "Air-Cooled Refrigerant Condensers."

N. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.
2. House in a unit-mounted, NEMA 250, Type 1 enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Field-power interface shall be to instantaneous-trip circuit breaker with lockable handle.
   a. Disconnect means shall be interlocked with door operation.
   b. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 100,000 A.
5. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:
   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

6. Provide each motor with overcurrent protection.

7. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.


9. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.


11. For chiller electrical power supply, indicate the following:
   a. Current and phase to phase for all three phases.
   b. Voltage, phase to phase, and phase to neutral for all three phases.
   c. Three-phase real power (kilowatts).
   d. Three-phase reactive power (kilovolt amperes reactive).
   e. Power factor.
   f. Running log of total power versus time (kilowatt-hours).
   g. Fault log, with time and date of each.

O. Compressor Motor Controllers:
   1. Across the Line: NEMA ICS 2, Class A, full voltage, non-reversing.
   2. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed or open transition or solid state.

P. Controls:
   1. Standalone and microprocessor based.
   2. Enclosure: Share enclosure with electrical-power devices or provide a separate enclosure of matching construction.
   3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:
a. Date and time.
b. Operating or alarm status.
c. Fault history with not less than last 10 faults displayed.
d. Set points of controllable parameters.
e. Trend data.
f. Operating hours.
g. Number of chiller starts.
h. Outdoor-air temperature or space temperature if required for chilled-water reset.
i. Temperature and pressure of operating set points.
j. Entering- and leaving-fluid temperatures of evaporator and condenser.
k. Difference in fluid temperatures of evaporator and condenser.
l. Refrigerant pressures in evaporator and condenser.
m. Refrigerant saturation temperature in evaporator and condenser.
n. No cooling load condition.
o. Elapsed time meter (compressor run status).
p. Pump status.
q. Anti-recycling timer status.
r. Percent of maximum motor amperage.
s. Current-limit set point.
t. Number of compressor starts.
u. Compressor refrigerant suction and discharge temperature.
v. Oil temperature.
w. Oil discharge pressure.
x. Phase current.
y. Percent of motor rated load amperes.
z. Phase voltage.

4. Control Functions:

a. Manual or automatic startup and shutdown time schedule.
b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water temperature.
c. Current limit and demand limit.
d. Condenser-fluid temperature.
e. External chiller emergency stop.
f. Anti-recycling timer.
g. Automatic lead-lag switching.
h. Variable evaporator flow.
i. Thermal storage.
5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:
   a. Low evaporator pressure, or high condenser pressure.
   b. Low chilled-water temperature.
   c. Refrigerant high pressure.
   d. High or low oil pressure.
   e. High oil temperature.
   f. Loss of chilled-water flow.
   g. Loss of condenser-fluid flow.
   h. Control device failure.
   i. Manually reset safety controls.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

9. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.
   a. ASHRAE 135 BacNet or LonTalk or ModBus Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

Q. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 3/4 inch
3. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. Factory-applied insulation over cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe.
from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

a. Before insulating steel surfaces, prepare surfaces for paint, prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
b. Seal seams and joints to provide a vapor barrier.
c. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

R. Finish:

1. Paint chiller, using manufacturer’s standard procedures, except comply with the following minimum requirements:

   a. Provide at least one coat of primer.
   b. Provide finish coat of alkyd-modified, vinyl enamel
   c. Paint surfaces that are to be insulated before applying the insulation.
   d. Paint installed insulation to match adjacent un-insulated surfaces.

S. Accessories:

1. Factory-furnished, chilled-and condenser water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
3. Factory-furnished neoprene or spring isolators for field installation.

T. Capacities and Characteristics:

2. Full-Load Efficiency (COP): <Insert value>.
3. Full-Load Efficiency (EER): <Insert value>.
5. Part-Load Efficiency (IPLV): <Insert value>.
7. Evaporator:

   b. Number of Passes: One Two Three.
   c. Fluid Type: Water <Insert fluid type>.
   d. Design Fluid Flow Rate: <Insert gpm>.
e. Minimum Fluid Flow Rate: <Insert gpm>.
f. Entering-Fluid Temperature: <Insert deg F>.
g. Leaving-Fluid Temperature: <Insert deg F>.
h. Fluid Pressure Drop: <Insert feet of head>.
i. Fluid Velocity: <Insert fps>.
j. Fouling Factor: 0.0005 sq. ft. x h x deg F/Btu <Insert value>.

8. Condenser:

b. Fluid Type: Water <Insert fluid type>.
c. Design Fluid Flow Rate: <Insert gpm>.
d. Entering-Fluid Temperature: <Insert deg F>.
e. Leaving-Fluid Temperature: <Insert deg F>.
f. Fluid Pressure Drop: <Insert feet of head>.
g. Fluid Velocity: <Insert fps>.
h. Fouling Factor: 0.001 sq. ft. x h x deg F/Btu

9. Number of Refrigerant Circuits: Two.

10. Compressors:

a. Number of Compressors: <Insert number>.
b. Rated Load Amperes: <Insert value>.
c. Locked-Rotor Amperes: <Insert value>.

11. Control Electrical Requirements:

a. Power Connection: Fed through integral transformer
c. Minimum Circuit Ampacity: <Insert value>.
d. Maximum Overcurrent Protection Device: <Insert amperage>.
e. Volts: 120 <Insert value>-V ac.
f. Phase: Single Three.
g. Hertz: 60.

12. Chiller Electrical Requirements:

b. Power Factor: <Insert value>.
c. Minimum Circuit Ampacity: <Insert value>.
d. Maximum Overcurrent Protection Device: <Insert amperage>.
e. Volts: 208 240 480 600 <Insert value>.

f. Phase: Three.

g. Hertz: 60.

13. Noise Rating: 85 dBA sound power level when measured according to ARI 575. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

2.3 PACKAGED, AIR-COOLED CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a United Technologies company.

2. Trane; a division of American Standard.

3. YORK International Corporation.

B. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.

D. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.

2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.


4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstand a 1000-hour salt-spray test according to ASTM B 117.

5. Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:

a. Acoustic enclosure around compressors.

b. Reduced-speed fans with acoustic treatment.

E. Compressors:

1. Description: Positive displacement, hermetically sealed.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one- or two-rotor design.
4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.

F. Service: Easily accessible for inspection and service.

G. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 10 percent of design capacity.
3. Condenser-Air Unloading Requirements over Operating Range: Drop-in entering condenser-air temperature of 5 deg F drop for each 10 percent in capacity reduction \(<\text{Insert conditions}>.\)
4. For units equipped with a variable frequency controller, capacity control shall be both "valve-less" and "step-less," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.
   a. Capacity Control (with VFD's): Compressors shall start at minimum load. Capacity control range from 100% to 10% of chiller full load. Provide Microprocessor control to command compressor capacity to balance compressor capacity with cooling load. Capacity control system shall be both "valve-less" and "step-less" requiring no slide valve or capacity control valve(s) to operate at reduced capacity.

H. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Factory-installed and pressure-tested piping with isolation valves and accessories.
4. Oil compatible with refrigerant and chiller components.
5. Positive visual indication of oil level.

I. Vibration Control:

1. Vibration Balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.
   a. Over speed Test: 25 percent above design operating speed.

2. Isolation: Mount individual compressors on vibration isolators.

J. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, induction type with inherent thermal-overload protection on each phase.

K. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing, or solid state.
2. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition, or solid state.
3. Variable Frequency Controller:
   a. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
   b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
   c. Enclosure: Unit mounted, NEMA 250, Type 3R with hinged full-front access door with lock and key.
   d. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 100,000 A.
   e. Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
   f. Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.
L. Refrigerant Circuits:
1. Refrigerant Type: R-134a or R-407c. Classified as Safety Group A1 according to ASHRAE 34.
2. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
3. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-corefilter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
4. Pressure Relief Device:
   a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

M. Evaporator:
1. Description: Shell-and-tube design.
   a. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
4. Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.
5. Fluid Nozzles: Terminated with flanged end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
7. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.

N. Air-Cooled Condenser:
1. Plate-fin coil with integral sub-cooling on each circuit, rated at 450 psig.
a. Construct coil casing of galvanized steel.
b. Construct coils of copper tubes mechanically bonded to aluminum with precoated epoxy-phenolic fins.
c. Coat coils with a baked-epoxy, corrosion-resistant coating after fabrication.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

3. Fan Motors: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.

4. Fan Guards: Steel safety guards with corrosion-resistant coating.

O. Electrical Power:

1. Factory-installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.

2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.

3. Wiring shall be numbered and color-coded to match wiring diagram.

4. Install factory wiring outside of an enclosure in a raceway.

5. Field-power interface shall be NEMA AB, instantaneous-trip circuit breaker with lockable handle.

   a. Disconnect means shall be interlocked with door operation.
   b. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 100,000 A.

6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:

   a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

7. Provide each motor with overcurrent protection.

8. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
10. Provide power factor correction capacitors to correct power factor to 0.95 at full load.
11. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

   a. Power unit-mounted controls where indicated.
   b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

13. For chiller electrical power supply, indicate the following:

   a. Current and phase to phase for all three phases.
   b. Voltage, phase to phase, and phase to neutral for all three phases.
   c. Three-phase real power (kilowatts).
   d. Three-phase reactive power (kilovolt amperes reactive).
   e. Power factor.
   f. Running log of total power versus time (kilowatt-hours).
   g. Fault log, with time and date of each.

P. Controls:

1. Standalone and microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure for remote mounting in the field.
3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:

   a. Date and time.
   b. Operating or alarm status.
   c. Operating hours.
   d. Outdoor-air temperature if required for chilled-water reset.
   e. Temperature and pressure of operating set points.
   f. Entering and leaving temperatures of chilled water.
   g. Refrigerant pressures in evaporator and condenser.
   h. Saturation temperature in evaporator and condenser.
   i. No cooling load condition.
   j. Elapsed time meter (compressor run status).
   k. Pump status.
   l. Anti-recycling timer status.
m.  Percent of maximum motor amperage.

n.  Current-limit set point.

o.  Number of compressor starts.

4. Control Functions:

   a.  Manual or automatic startup and shutdown time schedule.

   b.  Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water temperature.

   c.  Current limit and demand limit.

   d.  External chiller emergency stop.

   e.  Anti-recycling timer.

   f.  Automatic lead-lag switching.

   g.  Variable evaporator flow.

   h.  Thermal storage.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

   a.  Low evaporator pressure or high condenser pressure.

   b.  Low chilled-water temperature.

   c.  Refrigerant high pressure.

   d.  High or low oil pressure.

   e.  High oil temperature.

   f.  Loss of chilled-water flow.

   g.  Control device failure.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

9. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

   a.  ASHRAE 135 BacNet or LonTalk or ModBus Industry-accepted, open-protocol communication interface with the BAS shall enable the BAS operator to remotely
control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

Q. Insulation:
1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness 1-1/2 inches
3. Factory-applied insulation over cold surfaces of chiller components.
   a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.
4. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

R. Accessories:
1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
3. Factory-furnished neoprene or spring isolators for field installation.

S. Capacities and Characteristics:
2. Full-Load Efficiency (COP): <Insert value>.
3. Full-Load Efficiency (EER): <Insert value>.
5. Part-Load Efficiency (IPLV): <Insert value>.
7. Low Ambient Operation: Chiller designed for operation to 0 deg F <Insert temperature>.
8. High Ambient Operation: Chiller designed for operation to 115 deg F <Insert temperature>.
9. Evaporator:
   a. Configuration: Integral to chiller Shipped loose for field installation.
   b. Pressure Rating: 150 psig 300 psig <Insert value>.
   c. Fluid Type: Water <Insert fluid type>.
d. Design Fluid Flow Rate: <Insert gpm>.

e. Minimum Fluid Flow Rate: <Insert gpm>.

f. Entering-Fluid Temperature: <Insert deg F>.

g. Leaving-Fluid Temperature: <Insert deg F>.

h. Fluid Pressure Drop: <Insert feet of head>.

i. Fluid Velocity: <Insert fps>.

j. Fouling Factor: 0.0001 sq. ft. x h x deg F/Btu 0.00025 sq. ft. x h x deg F/Btu <Insert value>.


12. Site Altitude: <Insert feet>.

13. Number of Refrigerant Circuits: Two Each compressor on an independent circuit <Insert requirement>.

14. Compressor:

   a. Number of Compressors: <Insert number>.
   b. Rated Load Amperes: <Insert value>.
   c. Locked-Rotor Amperes: <Insert value>.

15. Control Electrical Requirements:

   c. Minimum Circuit Ampacity: <Insert value>.
   d. Maximum Overcurrent Protection Device: <Insert amperage>.
   e. Volts: 120 <Insert value>-V ac.
   f. Phase: Single.
   g. Hertz: 60.

16. Chiller Electrical Requirements:

   b. Power Factor: <Insert value>.
   c. Minimum Circuit Ampacity: <Insert value>.
   d. Maximum Overcurrent Protection Device: <Insert amperage>.
   e. Volts: 208 240 480 600 <Insert value>.
   f. Phase: Three.
   g. Hertz: 60.
17. Noise Rating: 85 dBA sound power level when measured according to ARI 370. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

2.4 PACKAGED REFRIGERANT RECOVERY UNITS

A. Packaged portable unit consisting of compressor, air-cooled condenser, recovery system, tank pressure gages, filter-dryer, and valving that allows for switching between liquid and vapor recovery mode. Refrigerant recovery unit shall be factory mounted on an ASME-constructed and stamped refrigerant storage vessel that is sized to hold the full refrigerant charge of the largest chiller furnished.

2.5 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM

A. Furnish for field installation a brush-cleaning system on each chiller condenser for tube cleaning and improved heat transfer.

B. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.

C. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.

D. Components:

1. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch.
3. Four-Way Valve:
   a. Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.
b. Configure valve with parallel flow connections to minimize field installation piping.
c. Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.
d. Pipe connections shall be flanged.
e. Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.
f. Hydrostatically test to 1.5 times the design working pressure.
g. Design the valve to cause no more than 0.5-psig pressure drop at design flow conditions.
h. Provide valve with valve-mounted indicating/warning light, which shall light before valve begins rotation.
i. Valve Actuator: Mount electric actuator to operate valve.
j. Position Switches: Factory mount micro-switches on valve to indicate the complete turn of valve in both normal and reverse flow.

4. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:
   
a. NEMA 250, Type 12 enclosure.
b. Timer to automatically initiate the cleaning cycle over a 24-hour period.
e. For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
f. Flow switch bypass.
g. Unloading signal to chiller.

2.6 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.

B. Factory test and inspect evaporator and condenser and heat-reclaim condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. For chillers located indoors, rate sound power level according to ARI 575.
D. For chillers located outdoors, rate sound power level according to ARI 370.

END OF SECTION 236426
COOLING TOWERS
SECTION 236500 - COOLING TOWERS

PART-1  GENERAL

1.1  SUMMARY

A. Section Includes:

1. Closed-circuit, forced-draft, counterflow cooling towers.
2. Closed-circuit, induced-draft, combined-flow cooling towers.
3. Closed-circuit, induced-draft, counterflow cooling towers.
4. Open-circuit, forced-draft, counterflow cooling towers.
5. Open-circuit, induced-draft, counterflow cooling towers.

1.2  QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE/IESNA 90.1 for energy efficiency.

D. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

F. FMG approval and listing in the latest edition of FMG's "Approval Guide."

1.3  FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.
B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Certificates: For certification required in "Quality Assurance" Article.

D. Seismic Qualification Certificates: For cooling towers, accessories, and components, from manufacturers.

E. Factory quality-control and test reports.

F. Startup service reports.

G. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Completely factory assembled, piped and wired, requiring no field assembly except as noted, suitable for installation in the space conditions indicated on drawings, including clearance for installation, operation, maintenance, and air flow into and out of tower. Cooling tower manufacturer shall certify tower for space conditions given.

B. Equipment design shall be of bolted or continuously welded construction. Spot welded construction is not permitted.

C. Designed for wind load of in accordance with authorities having jurisdiction

D. Provide 120 volt motor heaters to operate when motors are not operative and ambient temperature drops below 40°F with all accessories necessary for a complete operating system, including
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Engineering Design Standards
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a. A transformer from line voltage to 120 volts
b. Low voltage disconnect
c. Secondary fuses located in motor controller enclosure. Provide oversize enclosure or utilize an extra section of motor control center.
d. Terminal block for field connections.

E. Provide 350 watt immersion heater and built-in and pre-wired thermostat for all Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve. Provide suitable electric control relays for make-up water control. Make-up control circuits and electrode heater circuits shall be suitable for 120 volts. Provide suitable transformers if required.

2.2 CLOSED-CIRCUIT, FORCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide one of the following:

2. Evapco Inc.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 40 lbf/sq. ft.

D. Casing and Frame:

   Frame Material: Galvanized steel, ASTM A 653/A 653M, G235 coating
2. Fasteners: Galvanized steel
3. Joints and Seams: Sealed watertight
4. Welded Connections: Continuous and watertight

E. Collection Basin:

1. Material: Stainless steel
2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices
3. Overflow and drain connections
4. Makeup water connection
5. Basin Sweeper Distribution Piping and Nozzles:
   a. Pipe Material: PVC
   b. Nozzle Material: Plastic
   c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   1. Enclosure: NEMA 250, Type 4
   2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
   4. Water Stilling Chamber: Corrosion-resistant material
   5. Solenoid Valve: Slow closing with stainless-steel body, controlled and powered through level controller in response to water-level set point.
   6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Electric Basin Heater:
   2. Heater Control Panel: Mounted on the side of each cooling tower cell.
   3. Enclosure: NEMA 250 Type 4
   4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
   5. Control-circuit transformer with primary and secondary side fuses.
   6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
   7. Single-point, field-power connection to a non-fused circuit breaker and heater branch circuiting complying with NFPA 70.
   8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid-tight conduit.

H. Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

I. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.
J. Water Distribution Piping: Main header and lateral branch piping designed for even distribution over fill throughout the flow range without the need for balancing valves and for connecting individual, removable, non-clogging spray nozzles.

1. Pipe Material: Galvanized steel
2. Spray Nozzle Material: Polypropylene
3. Piping Supports: Corrosion-resistant hangers and supports designed to resist movement during operation and shipment.

K. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

1. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed
4. Service Factor: 1.15

L. Heat-Exchanger Coils:

1. Tube and Tube Sheet Materials: Copper tube with stainless-steel sheet Retain one of first two subparagraphs below. Second subparagraph is only available with hot-dip galvanized steel tubes. Coordinate with subparagraph above and "Quality Assurance" Article.
2. Heat-Exchanger Arrangement: Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube; and sloped for complete drainage of fluid by gravity.
3. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.
4. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.

M. Removable Drift Eliminator:

1. Material: FRP or PVC with maximum flame-spread index of 25 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multi-pass, designed and tested to reduce water carryover to achieve performance indicated.

N. Removable Air-Intake Screens: Stainless steel wire mesh.

O. Centrifugal Fan: Double-width, double-inlet, forward-curved blades, and statically and dynamically balanced at the factory after assembly.
   1. Number of Fans: Each cooling tower cell shall have a single fan or multiple fans connected to a common shaft.
   2. Fan Wheel and Housing Materials: Galvanized steel.
   3. Fan Shaft: Steel, coated to resist corrosion.
   5. Fan Shaft Bearings: Self-aligning, grease-lubricated ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 1200,000 hours.
   6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

P. Belt Drive:
   1. Belt-Drive Service Factor: 1.5 based on motor nameplate horsepower.
   2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
   4. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.
   5. Belt-Drive Guard: Comply with OSHA regulations.
      a. Belt Drives: Each motor shall have belt drive complying with requirements for belt drives and configured for operation when other motor fails.

Q. Fan Motor:
   1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
   2. Motor Enclosure: Totally enclosed
   4. Service Factor: 1.15
5. Insulation: Class H


7. Severe-duty rating with the following features:
   
   a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
   b. Double-shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F.
   c. Internal heater automatically energized when motor is de-energized. Provide all required wiring, controls and thermostats.

8. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

R. Discharge Hoods:

1. Hood Configuration: Tapered totally surrounding drift eliminators and constructed of same material as casing; and having factory-installed insulation and access doors.

2. Discharge Dampers: Positive-closure, automatic, isolation dampers with electric actuators.
   
   a. Provide field power and controls to open dampers when pump is energized and close dampers when pump is de-energized.

S. Capacity-Control Dampers: Stainless-steel dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

T. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4

2. Vibration Detection: Sensor with a field-adjustable acceleration sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.

3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.

4. Switch shall, on sensing excessive vibration signal, an alarm through the BMS and shut down the fan.
U. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

V. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, Type 4 enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan and spray pump based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
8. Controls and wiring for "two-motor, single-fan drives" shall be same as two-speed, two-winding motor.
9. Power and controls to open discharge hood dampers when pump is energized and close dampers when pump is de-energized.
10. Single-point, field-power connection to a circuit breaker for each cooling tower cell.

   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

11. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid-tight conduit.
12. Visual indication of status and alarm with momentary test push button for each motor.
13. Audible alarm and silence switch.
14. Visual indication of elapsed run time, graduated in hours for each motor.
15. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
a. Operational status of each motor.
b. Position of dampers.
c. Cooling tower leaving-fluid temperature.
d. Fan vibration alarm.
e. Collection basin high- and low-water-level alarms.

W. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
   a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.

X. Capacities and Characteristics:

1. Number of Cells: Insert quantity).
2. Maximum Drift Loss: 0.005 percent of design water flow.
3. Heat-Exchanger Coil:
   a. Fluid Type: Water
   d. Fluid Pressure Drop: <Insert psig>.
   e. Entering-Fluid Temperature: <Insert deg F>.
   f. Leaving-Fluid Temperature: <Insert deg F>.
   g. Entering-Air Wet-Bulb Temperature: <Insert deg F>.
4. **Economizer Mode:**
   b. Entering-Fluid Temperature: <Insert deg F>.
   c. Leaving-Fluid Temperature: <Insert deg F>.
   d. Entering-Air Wet-Bulb Temperature: <Insert deg F>.

5. **Fan Location:** Bottom Side.

6. **Fan Motor:**
   a. Type: Variable speed.
   c. Full-Load Ampacity: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection Device: <Insert amperage>.
   f. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.

7. **Spray Pump and Motor:**
   c. Full-Load Ampacity: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection Device: <Insert amperage>.
   f. Electrical Characteristics: 120 208 240 277 480 <Insert value>-V ac, single 3 phase, 60 Hz.

8. **Sound Pressure Level:** <Insert dBA> at <Insert distance in feet> when measured according to CTI ATC 128.

9. **Basin Heater:**
   a. Basin Water Temperature: 40 deg F
   b. Outdoor Ambient Temperature: 0 deg F
   c. Capacity/Cell: <Insert kilowatts>.
   d. Full-Load Ampacity: <Insert value>.
   e. Minimum Circuit Ampacity: <Insert value>.
   g. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
   h. Capacity/Cell: <Insert MBtu/h>.
   i. Entering-Fluid Temperature: <Insert deg F>.
2.3 CLOSED-CIRCUIT, INDUCED-DRAFT, COMBINED-FLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide one of the following:

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 40 lbf/sq. ft.

D. Casing and Frame:
   1. Casing and Frame Material: Galvanized steel, ASTM A 653/A 653M, G235 coating Retain first subparagraph below and delete option in subparagraph heading above if frame material is different than casing.
   2. Fasteners: Galvanized steel.

E. Collection Basin:
   2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
   3. Overflow and drain connections.
   5. Basin Sweeper Distribution Piping and Nozzles:
      a. Pipe Material: PVC
      b. Nozzle Material: Plastic
c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   1. Enclosure: NEMA 250, Type 4
   2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
   4. Water Stilling Chamber: Corrosion-resistant material
   5. Solenoid Valve: Slow closing with stainless-steel body, controlled and powered through level controller in response to water-level set point.
   6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Electric Basin Heater:
   2. Heater Control Panel: Mounted on the side of each cooling tower cell.
   3. Enclosure: NEMA 250, Type 4
   4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
   5. Control-circuit transformer with primary and secondary side fuses.
   6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
   7. Single-point, field-power connection to a non-fused circuit breaker and heater branch circuiting complying with NFPA 70.
   8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid-tight conduit.

H. Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

I. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

J. Gravity Water Distribution Basin: Non-pressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.
2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
4. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
5. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant hardware.
6. Valves: Manufacturer’s standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity water distribution basin.

K. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, non-clogging spray nozzles.

1. Pipe Material Galvanized steel
2. Spray Nozzle Material: Polypropylene
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

L. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

1. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed
4. Service Factor: 1.15

M. Fill:

1. Materials: PVC with maximum flame-spread index of 25 according to ASTM E 84.
3. Fabrication: Fill-type sheets fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 F.

N. Heat-Exchanger Coils:
1. Tube and Tube Sheet Materials: Copper tube with stainless-steel sheet

2. Heat-Exchanger Arrangement: Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube; and sloped for complete drainage of fluid by gravity.

3. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1 and bearing ASME “U” stamp; and sloped for complete drainage of fluid by gravity.

4. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.

O. Drift Eliminator:

1. Material: FRP or PVC with maximum flame-spread index of 5 according to ASTM E 84.

2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

3. Configuration: Multi-pass, designed and tested to reduce water carryover to achieve performance indicated.

4. Fill Drift Eliminators: Separate and removable from fill.


P. Air-Intake Louvers:

1. Material: Matching casing.

2. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

3. Location: Separate from fill.


R. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: Aluminum

2. Hub Material: Aluminum First subparagraph below is an optional feature. Retain, based on Project conditions, to require feature.


5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 F. Bearings designed for an L-10 life of 120,000 hours.

6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

S. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.

1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse.
5. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling Retain first subparagraph below with second option in last subparagraph above.
6. Drive Shaft Material: Stainless steel, and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
7. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.

T. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed
4. Service Factor: 1.15
5. Insulation: Class H
7. Severe-duty rating with the following features:
   a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 F.
c. Internal heater automatically energized when motor is de-energized.

U. Fan Discharge Stack: Material shall match casing, velocity recovery design.

V. Vibration Switch: For each fan drive.
   1. Enclosure: NEMA 250, Type 4
   2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
   3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
   4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

W. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to a BMS.
   1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BMS.

X. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

Y. Control Package: Factory installed and wired, and functionally tested at factory before shipment.
   1. NEMA 250, Type 4 enclosure with removable internally mount backplate.
   2. Control-circuit transformer with primary and secondary side fuses.
   3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
   4. Microprocessor-based controller for automatic control of fan and spray pump based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
   5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
8. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.
9. Single-point, field-power connection to a circuit breaker
   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
10. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid-tight conduit.
11. Visual indication of status and alarm with momentary test push button for each motor.
12. Audible alarm and silence switch.
13. Visual indication of elapsed run time, graduated in hours for each motor.
14. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
   a. Operational status of each motor.
   b. Position of dampers.
   c. Cooling tower leaving-fluid temperature.
   d. Fan vibration alarm.
   e. Oil-level alarm.
   f. Collection basin high- and low-water-level alarms.

Z. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
   a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
   b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

AA. Capacities and Characteristics:

1. Number of Cells: <Insert quantity>.
2. Air-Inlet Arrangement: Two sides.
3. Maximum Drift Loss: 0.005 percent of design water flow.
4. Heat-Exchanger Coil:
   a. Fluid Type: Water
   d. Fluid Pressure Drop: <Insert psig>.
   e. Entering-Fluid Temperature: <Insert deg F>.
   f. Leaving-Fluid Temperature: <Insert deg F>.
   g. Entering-Air Wet-Bulb Temperature: <Insert deg F>.

5. Economizer Mode:
   b. Entering-Fluid Temperature: <Insert deg F>.
   c. Leaving-Fluid Temperature: <Insert deg F>.
   d. Entering-Air Wet-Bulb Temperature: <Insert deg F>.

6. Fan Drive: gear.
7. Fan Motor:
   a. Type: Variable speed
   c. Full-Load Ampacity: <Insert value>. 
d. Minimum Circuit Ampacity: <Insert value>.
e. Maximum Overcurrent Protection Device: <Insert amperage>.
f. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.

8. Spray Pump and Motor:
   c. Full-Load Ampacity: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection Device: <Insert amperage>.
   f. Electrical Characteristics: 120 208 240 277 480 <Insert value>-V ac, single 3 phase, 60 Hz.

9. Sound Pressure Level: <Insert dBA> at <Insert distance in feet> when measured according to CTI ATC 128.

10. Basin Heater:
   a. Basin Water Temperature: 40 deg F
   b. Outdoor Ambient Temperature: 0 deg
   c. Capacity/Cell: <Insert kilowatts>.
   d. Full-Load Ampacity: <Insert value>.
   e. Minimum Circuit Ampacity: <Insert value>.
   g. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
   h. Capacity/Cell: <Insert MBtu/h>.
   i. Entering-Fluid Temperature: <Insert deg F>.
   j. Fluid Flow Rate: <Insert gpm>.
   k. Fluid Pressure Drop: <Insert psig>.
   l. Capacity/Cell: <Insert MBtu/h>.
   m. Steam Flow: <Insert lb/h>.
   n. Steam Pressure: <Insert psig>.

2.4 CLOSED-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide the following:
   1. Evapco Inc.
B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 40 lbf/sq. ft.

D. Casing and Frame:
   5. Welded Connections: Continuous and watertight.

E. Collection Basin:
   2. Overflow and drain connections.

F. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   1. Enclosure: NEMA 250, Type 4.
   2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
   4. Water Stilling Chamber: Corrosion-resistant material.
   5. Solenoid Valve: Slow closing with stainless-steel body; controlled and powered through level controller in response to water-level set point.
   6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Electric Basin Heater:
   2. Heater Control Panel: Mounted on the side of each cooling tower cell.
   3. Enclosure: NEMA 250, Type 3R Type 4 Type 4X.
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.

5. Control-circuit transformer with primary and secondary side fuses.

6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.

7. Single-point, field-power connection to a fused disconnect switch nonfused disconnect switch circuit breaker and heater branch circuiting complying with NFPA 70.

8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

OR

H. Steam-Injector Basin Heater: Manufacturer’s standard offering to provide capacity indicated.

1. Pipe Material: Galvanized steel
2. Spray Nozzle Material: Polypropylene
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

I. Recirculating Piping: PVC

J. Spray Pump: Close-coupled, end-suction, single-stage, bronze-fitted centrifugal pump; with suction strainer and flow balancing valve, and mechanical seal suitable for outdoor service.

K. General Requirements for Spray Pump Motor: Comply with NEMA designation and temperaturerating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.

1. Motor Enclosure: Totally enclosed
2. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 and NEMA Premium Efficient.
3. Service Factor: 1.15

L. Heat-Exchanger Coils:

1. Tube and Tube Sheet Materials: Copper tube with stainless-steel sheet Retain one of first two subparagraphs below. Second subparagraph is only available with hot-dip galvanized-steel tubes. Coordinate with subparagraph above and "Quality Assurance" Article.
2. Heat-Exchanger Arrangement: Straight tubes with removable header cover plate on both ends of heat exchanger for straight-through access to each tube; and sloped for complete drainage of fluid by gravity.

3. ASME Compliance: Designed, manufactured, and tested according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1 and bearing ASME "U" stamp; and sloped for complete drainage of fluid by gravity.

4. Field Piping Connections: Vent, supply, and return suitable for mating to ASME B16.5, Class 150 flange.

M. Removable Drift Eliminator:

1. Material: FRP or PVC with maximum flame-spread index of 25 according to ASTM E84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multi-pass, designed and tested to reduce water carryover to achieve performance indicated.

N. Air-Intake Louvers:

1. Material: Matching casing.
2. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out during all modes of operation including operation with fans off.

O. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: Aluminum
2. Hub Material: Aluminum First subparagraph below is an optional feature. Retain, based on Project conditions, to require feature.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 120,000 hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

P. Belt Drive:

1. Service Factor: 1.5 based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.


4. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.

5. Belt-Drive Guard: Comply with OSHA regulations.

Q. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.

2. Motor Enclosure: Totally enclosed


4. Service Factor: 1.15

5. Insulation: Class H


7. Severe-duty rating with the following features:
   a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
   b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 F.
   c. Internal heater automatically energized when motor is de-energized.

R. Fan Discharge Stack: Material shall match casing, velocity recovery design.

1. Enclosure: NEMA 250, Type 4

2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.

3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.

4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.
S. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

T. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, Type 4 enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan and spray pump based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
6. .
7. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
8. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
9. Single-point, field-power connection to a circuit breaker for each cooling tower cell.
   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
10. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid-tight conduit.
11. Visual indication of status and alarm with momentary test push button for each motor.
12. Audible alarm and silence switch.
13. Visual indication of elapsed run time, graduated in hours for each motor.
14. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
   a. Operational status of each motor.
   b. Cooling tower leaving-fluid temperature.
   c. Fan vibration alarm.
d. Collection basin high- and low-water-level alarms.

U. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.

2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.


5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.

a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.

b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

V. Capacities and Characteristics:

1. Number of Cells: Insert quantity>.

2. Maximum Drift Loss: 0.005 percent of design water flow.

3. Heat-Exchanger Coil:

a. Fluid Type: Water <Insert type>.


d. Fluid Pressure Drop: <Insert psig>.

e. Entering-Fluid Temperature: <Insert deg F>.

f. Leaving-Fluid Temperature: <Insert deg F>.

4. Economizer Mode:
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b. Entering-Fluid Temperature: <Insert deg F>.
c. Leaving-Fluid Temperature: <Insert deg F>.
d. Entering-Air Wet-Bulb Temperature: <Insert deg F>.

5. Fan Motor:
   a. Type: Variable speed
c. Full-Load Ampacity: <Insert value>.
d. Minimum Circuit Ampacity: <Insert value>.
e. Maximum Overcurrent Protection Device: <Insert amperage>.
f. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.

6. Spray Pump and Motor:
c. Full-Load Ampacity: <Insert value>.
d. Minimum Circuit Ampacity: <Insert value>.
e. Maximum Overcurrent Protection Device: <Insert amperage>.
f. Electrical Characteristics: 120 208 240 277 480 <Insert value>-V ac, single 3 phase, 60 Hz.

7. Sound Pressure Level: <Insert dBA> at <Insert distance in feet> when measured according to CTI ATC 128.

8. Basin Heater:
   a. Basin Water Temperature: 40 deg F
   b. Outdoor Ambient Temperature: 0 deg F Retain first five subparagraphs below for projects with electric basin heaters.
c. Capacity/Cell: <Insert kilowatts>.
d. Full-Load Ampacity: <Insert value>.
e. Minimum Circuit Ampacity: <Insert value>.
g. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
   Retain first four subparagraphs below for projects with hot-water-coil basin heaters.
h. Capacity/Cell: <Insert MBtu/h>.
i. Entering-Fluid Temperature: <Insert deg F>.
2.5 OPEN-CIRCUIT, FORCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide one of the following:

2. Evapco Inc.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 40 lbf/sq. ft.

D. Casing and Frame:

2. Fasteners: Galvanized steel.

E. Collection Basin:

2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
3. Overflow and drain connections.
5. Basin Sweeper Distribution Piping and Nozzles:
   a. Pipe Material: PVC
   b. Nozzle Material: Plastic
c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosure: NEMA 250, Type 4
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
4. Water Stilling Chamber: Corrosion-resistant material
5. Solenoid Valve: Slow closing with stainless-steel body, controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Electric Basin Heater:

2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, Type 4
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a circuit breaker and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

H. Steam-Injector Basin Heater: Manufacturer’s standard offering to provide capacity indicated.

1. Pipe Material: Galvanized steel
2. Spray Nozzle Material: Polypropylene
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.
I. Fill:
   1. Materials: PVC with maximum flame-spread index of 5 according to ASTM E 84.
   3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
   4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 F Retain option in first paragraph below to limit placement of drift eliminators.

J. Removable Drift Eliminator:
   1. Material FRP or PVC with maximum flame-spread index of 25
   2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
   3. Configuration: Multi-pass, designed and tested to reduce water carryover to achieve performance indicated.


L. Centrifugal Fan: Double-width, double-inlet, forward-curved blades, and statically and dynamically balanced at the factory after assembly.
   1. Number of Fans: Each cooling tower cell shall have a single fan or multiple fans connected to a common shaft.
   2. Fan Wheel and Housing Materials: Galvanized steel.
   3. Fan Shaft: Steel, coated to resist corrosion.
   5. Fan Shaft Bearings: Self-aligning, grease-lubricated ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 F. Bearings designed for an L-10 life of 120,000 hours.
   6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

M. Belt Drive:
   1. Service Factor: 1.5 based on motor nameplate horsepower.
   2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
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4. Belt Material: Oil resistant, non-static conducting, and constructed of neoprene polyester cord.

5. Belt-Drive Guard: Comply with OSHA regulations.

N. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.

2. Motor Enclosure: Totally enclosed

3. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 and NEMA Premium Efficient

4. Service Factor: 1.15

5. Insulation Class H


7. Severe-duty rating with the following features:
   a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
   b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and 300 F.
   c. Internal heater automatically energized when motor is de-energized.

8. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

O. Discharge Hoods:

1. Hood Configuration: Tapered totally surrounding drift eliminators and constructed of same material as casing; and having factory-installed insulation and access doors.

2. Discharge Dampers: Positive-closure, automatic, isolation dampers with electric actuators.

P. Capacity-Control Dampers: Galvanized-steel dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

Q. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.

3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.

4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

R. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

S. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, Type 4 enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
6. Factory-installed and wired, collection basin electric/electronic level controller.
7. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
8. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
9. Controls and wiring for "two-motor, single-fan drives" shall be same as two-speed, two-winding motor.
10. Single-point, field-power connection to a circuit breaker

   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.

   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
11. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid-tight conduit.

12. Visual indication of status and alarm with momentary test push button for each motor.

13. Audible alarm and silence switch.

14. Visual indication of elapsed run time, graduated in hours for each motor.

15. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
   a. Operational status of each motor.
   b. Position of dampers.
   c. Cooling tower leaving-fluid temperature.
   d. Fan vibration alarm.
   e. Collection basin high- and low-water-level alarms.

T. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.

2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.


5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
   a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
   b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

U. Capacities and Characteristics:

1. Number of Cells: <Insert quantity>.
3. Maximum Drift Loss: 0.005 <Insert number> percent of design water flow.
8. Leaving-Water Temperature: <Insert deg F>.
10. Economizer Mode:
   b. Entering-Water Temperature: <Insert deg F>.
   c. Leaving-Water Temperature: <Insert deg F>.
   d. Entering-Air Wet-Bulb Temperature: <Insert deg F>.
11. Fan Location: Bottom or side.
12. Fan and Drive Type: Axial with direct drive or centrifugal with belt drive.
13. Fan Motor:
   a. Type: Variable speed.
   c. Full-Load Ampacity: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection Device: <Insert amperage>.
   f. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
14. Sound Pressure Level: <Insert dBA> at <Insert distance in feet> when measured according to CTI ATC 128.
15. Basin Heater:
   a. Basin Water Temperature: 40 deg F
   b. Outdoor Ambient Temperature: 0 deg F
   c. Retain first five subparagraphs below for projects with electric basin heaters.
   d. Capacity/Cell: <Insert kilowatts>.
   e. Full-Load Ampacity: <Insert value>.
   f. Minimum Circuit Ampacity: <Insert value>.
   g. Maximum Overcurrent Protection Device: <Insert amperage>.
   h. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
   i. Capacity/Cell: <Insert MBtu/h>.
2.6 OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide one of the following:
   1. Evapco Inc.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 40 lbf/sq. ft.

D. Casing and Frame:
      Retain first subparagraph below and delete option in subparagraph heading above if frame material is different than casing.
   2. Fasteners: Galvanized steel.

E. Collection Basin:
   2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
   3. Overflow and drain connections.
   6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
   7. Equalizer connection for field-installed equalizer piping.
   8. Basin Sweeper Distribution Piping and Nozzles:
      a. Pipe Material: PVC
b. Nozzle Material: Plastic

Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosure: NEMA 250, Type 4
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, control of water makeup valve and low-level alarm, control of water makeup valve and low- and high-level alarms, control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
4. Water Stilling Chamber: Corrosion-resistant material
5. Solenoid Valve: Slow closing with stainless-steel body; controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosure: NEMA 250, Type 4
2. Controller: Ultrasonic level sensor/transmitter and relays factory wired to a terminal strip to control water makeup valve and signal a level alarm. Controller shall provide continuous level indication through a 4- to 20-mA signal for connection to BMS.
3. Water Stilling Chamber: Corrosion-resistant material
4. Solenoid Valve: Slow closing with stainless-steel body; controlled and powered through level controller in response to water-level set point.
5. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

H. Electric Basin Heater:

2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, Type 4
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a circuit breaker and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid-tight conduit.

I. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.

1. Pipe Material: Galvanized steel
2. Spray Nozzle Material: Polypropylene
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

J. Fill:

1. Materials: PVC resistant to rot, decay, and biological attack; with maximum flame-spread index of 25 according to ASTM E 84.
3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 F Retain option in first paragraph below to limit placement of drift eliminators.

K. Removable Drift Eliminator:

1. Material: FRP or PVC resistant to rot, decay, and biological attack; with maximum flame-spread index of 25 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multi-pass, designed and tested to reduce water carryover to achieve performance indicated.

L. Air-Intake Louvers:

1. Material: Matching casing.
2. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

M. Removable Air-Intake Screens: Stainless-steel wire mesh.

N. Axial Fan: Balanced at the factory after assembly.
   1. Blade Material: Aluminum
   2. Hub Material: Aluminum
   5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 F. Bearings designed for an L-10 life of 1200,000 hours.
   6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

O. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
   1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
   2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
   3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
   4. Operation: Able to operate both forward and in reverse.
   5. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling
   6. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.

P. Fan Motor:
   1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed
4. Service Factor: 1.15
5. Insulation: Class H
7. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
8. Severe-duty rating with the following features:
   a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
   b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 F.
   c. Internal heater automatically energized when motor is de-energized.

Q. Fan Discharge Stack: Material shall match casing, velocity recovery design.

R. Vibration Switch: For each fan drive.
   1. Enclosure: NEMA 250, Type 4
   2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
   3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
   4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

S. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to a BMS.
   1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BMS.

T. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."
U. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, Type 4 enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
8. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.
9. Single-point, field-power connection to a circuit breaker for each cooling tower cell.
   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
10. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid-tight conduit.
11. Visual indication of status and alarm with momentary test push button for each motor.
12. Audible alarm and silence switch.
13. Visual indication of elapsed run time, graduated in hours for each motor.
14. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
   a. Operational status of each motor.
   b. Position of dampers.
   c. Cooling tower leaving-fluid temperature.
   d. Fan vibration alarm.
   e. Oil-level alarm.
f. Collection basin high- and low-water-level alarms.

V. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
   a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
   b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

W. Capacities and Characteristics:

1. Number of Cells: <Insert quantity>.
2. Air-Inlet Arrangement: All sides.
3. Maximum Drift Loss: 0.005 <Insert number> percent of design water flow.
8. Leaving-Water Temperature: <Insert deg F>.
10. Economizer Mode:
    b. Entering-Water Temperature: <Insert deg F>.
c. Leaving-Water Temperature: <Insert deg F>.
d. Entering-Air Wet-Bulb Temperature: <Insert deg F>.

11. Fan Drive: gear.
12. Fan Motor:
   a. Type: Variable speed
   c. Full-Load Ampacity: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection Device: <Insert amperage>.
   f. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.

13. Sound Pressure Level: <Insert dBA> at <Insert distance in feet> when measured according to CTI ATC 128.
14. Basin Heater:
   a. Basin Water Temperature: 40 deg F
   b. Outdoor Ambient Temperature: 0 deg F
   c. Retain first five subparagraphs below for projects with electric basin heaters.
   d. Capacity/Cell: <Insert kilowatts>.
   e. Full-Load Ampacity: <Insert value>.
   f. Minimum Circuit Ampacity: <Insert value>.
   g. Maximum Overcurrent Protection Device: <Insert amperage>.
   h. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
   i. Capacity/Cell: <Insert MBtu/h>.
   j. Entering-Fluid Temperature: <Insert deg F>.
   k. Fluid Flow Rate: <Insert gpm>.
   l. Fluid Pressure Drop: <Insert psig>.
   m. Capacity/Cell: <Insert MBtu/h>.
   n. Steam Flow: <Insert lb/h>.
   o. Steam Pressure: <Insert psig>.

2.7 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide one of the following:
B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 40 lbf/sq. ft.

D. Casing and Frame:
   1. Casing and Frame Material: ASTM A 653/A 653M, G235 coating Retain first subparagraph below and delete option in subparagraph heading above if frame material is different than casing.
   3. Welded Connections: Continuous and watertight.

E. Collection Basin:
   2. Removable stainless-steel strainer with openings smaller than nozzle orifices.
   3. Overflow and drain connections.
   6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
   7. Equalizer connection for field-installed equalizer piping.
   8. Basin Sweeper Distribution Piping and Nozzles:
      a. Pipe Material: PVC
      b. Nozzle Material: Plastic
      c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer’s standard adjustable, mechanical float assembly and valve.

G. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:
   1. Enclosures: NEMA 250, Type 4
   2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
4. Water Stilling Chamber: Corrosion-resistant material
5. Solenoid Valve: Slow closing with stainless-steel body, controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

H. Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve:
1. Enclosure: NEMA 250, Type 4
2. Controller: Ultrasonic level sensor/transmitter and relays factory wired to a terminal strip to control water makeup valve and signal a level alarm. Controller shall provide continuous level indication through a 4- to 20-mA signal for connection to BMS.
3. Water Stilling Chamber: Corrosion-resistant material
4. Solenoid Valve: Slow closing with stainless-steel body; controlled and powered through level controller in response to water-level set point.
5. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

I. Electric Basin Heater:
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, Type 4
4. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
5. Control-circuit transformer with primary and secondary side fuses.
6. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
7. Single-point, field-power connection to a circuit breaker and heater branch circuiting complying with NFPA 70.
8. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquid-tight conduit.

J. Steam-Coil Basin Heater: Manufacturer's standard offering to provide capacity indicated.

K. Steam-Injector Basin Heater: Manufacturer's standard offering to provide capacity indicated.
L. Gravity Water Distribution Basin: Non-pressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
5. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
6. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant hardware.
7. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.
8. Single-Inlet, Field Pipe Connection: PVC pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the bottom side unless otherwise indicated.

M. Fill:

1. Materials: PVC, with maximum flame-spread index of 25 according to ASTM E 84.
3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 F

N. Drift Eliminator:

1. Material FRP or PVC with maximum flame-spread index of 25 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multi-pass, designed and tested to reduce water carryover to achieve performance indicated.
4. Location: Separate and removable from fill.
O. Air-Intake Louvers:
   1. Material: Matching casing.
   2. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
   3. Location Separate from fill.

P. Removable Air-Intake Screens: Stainless-steel wire mesh.

Q. Axial Fan: Balanced at the factory after assembly.
   1. Blade Material: Aluminum
      Hub Material: Aluminum First subparagraph below is an optional feature. Retain, based on Project conditions, to require feature.
   4. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 120,000 hours.
   5. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

R. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.
   1. Gear Drive and Coupling Service Factor: 2.0 based on motor nameplate horsepower.
   2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
   3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
   4. Operation: Able to operate both forward and in reverse.
   5. Drive-to-Motor Connection: Close coupled to motor using a flexible coupling Retain first subparagraph below with second option in last subparagraph above.
   6. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.
S. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed
4. Service Factor: 1.15
5. Insulation: Class H
7. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
8. Severe-duty rating with the following features:
   a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
   b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 F.
   c. Internal heater automatically energized when motor is de-energized.

T. Fan Discharge Stack: Material shall match casing, velocity recovery design.

U. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Provide switch with manual-reset button for field connection to a BMS and hardwired connection to fan motor electrical circuit.
4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

V. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to a BMS.

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BMS.
W. Capacity-Control Dampers: Galvanized-steel dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

X. Controls: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

Y. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, Type 4 enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
7. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
8. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.
9. Single-point, field-power connection to circuit breaker
   a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
   b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.
10. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid-tight conduit.
11. Visual indication of status and alarm with momentary test push button for each motor.
12. Audible alarm and silence switch.
13. Visual indication of elapsed run time, graduated in hours for each motor.
14. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
Z. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
   a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
   b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

AA. Capacities and Characteristics:

1. Number of Cells: <Insert quantity>.
3. Maximum Drift Loss: 0.005 <Insert number> percent of design water flow.
8. Leaving-Water Temperature: <Insert deg F>.
10. Economizer Mode:
    b. Entering-Water Temperature: <Insert deg F>.
    c. Leaving-Water Temperature: <Insert deg F>.
    d. Entering-Air Wet-Bulb Temperature: <Insert deg F>.
11. Fan Drive: gear.
12. Fan Motor:
    a. Type: Variable speed.
    c. Full-Load Ampacity: <Insert value>.
    d. Minimum Circuit Ampacity: <Insert value>.
    e. Maximum Overcurrent Protection Device: <Insert amperage>.
    f. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
13. Sound Pressure Level: <Insert dBA> at <Insert distance in feet> when measured according to CTI ATC 128.
14. Basin Heater:
    a. Basin Water Temperature: 40 deg F
    b. Outdoor Ambient Temperature: 0 deg F Retain first five subparagraphs below for projects with electric basin heaters.
    c. Capacity/Cell: <Insert kilowatts>.
    d. Full-Load Ampacity: <Insert value>.
    e. Minimum Circuit Ampacity: <Insert value>.
    g. Electrical Characteristics: 208 240 480 <Insert value>-V ac, 3 phase, 60 Hz.
    h. Capacity/Cell: <Insert MBtu/h>.
    i. Entering-Fluid Temperature: <Insert deg F>.
    j. Fluid Flow Rate: <Insert gpm>.
    k. Fluid Pressure Drop: <Insert psig>.
    l. Capacity/Cell: <Insert MBtu/h>.
    m. Steam Flow: <Insert lb/h>.
    n. Steam Pressure: <Insert psig>. 
2.8 SOURCE QUALITY CONTROL

A. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

B. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

END OF SECTION 236500
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT
SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Heat wheels.
   3. Fixed-plate sensible heat exchangers.
   4. Fixed-plate total heat exchangers.
   5. Packaged energy recovery units.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance: Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Rating Air-to-Air Energy Recovery Equipment."

C. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

D. UL Compliance: Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Non-ducted Heat Recovery Ventilators."

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include rated capacities, furnished specialties, and accessories.

B. LEED Submittals:
C. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Seismic Qualification Certificates: For air-to-air energy recovery equipment, accessories, and components, from manufacturer.

E. Factory quality-control and test reports.

F. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 HEAT WHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Loren Cook Company.
   2. SEMCO Incorporated.

B. Casing:
   1. Steel with standard factory-painted finish.
   2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch w.c. differential pressure.
   3. Casing seals on periphery of rotor and on duct divider and purge section.

C. Rotor: Aluminum segmented wheel strengthened with radial spokes with nontoxic, noncorrosive, silica-gel desiccant coating.

   1. Maximum Solid Size for Media to Pass: 500 micrometer.
D. Drive: Fractional horsepower motor and gear reducer with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

E. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
4. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

F. Extended-Surface, Non-supported-Media Filters:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
4. Factory-fabricated, dry, extended-surface, self-supporting ty
5. Initial Resistance: 0.28 inches wg.
6. Recommended Final Resistance: 1.0 inches wg>
8. MERV Efficiency: (ASHRAE 52.2): 13
9. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent.
10. Filter-Media Frame: Hard polyurethane foam
11. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for pre-filter.

2.2 HEAT-PIPE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Applied Air; a company of Mestek Technology Inc.
   2. Des Champs Technologies.
   3. Heat Pipe Technology, Inc.

B. Casing: Galvanized-steel flanged casing, with airtight partition between airstreams.

C. Refrigerant: ASHRAE 15, Group 1.

D. Tubes: 1-inch- diameter, copper Fins: Aluminum Retain fin spacing in first subparagraph below if not in a schedule.
   1. Fin Spacing: 0.125 inch
   2. Fin and Tube Joint: Mechanical bond

E. Coating: Epoxy apply to supply and exhaust.

F. Control: Pivot center of bottom of heat-pipe coil on shaft and bearings to tilt coil. Include tilt controls with electronic controller, electric actuator and linkage, thermostats, sensors, and polyester fabric with PVC-coated flexible connector for automatic supply temperature regulation, summer/winter changeover, and frost protection.

2.3 FIXED-PLATE SENSIBLE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Des Champs Technologies.

B. Casing: Galvanized steel with duct collars.

C. Casing Insulation: 1 inch thick, fiber free.

D. Drain Pan: Same material as casing, with drain connections on exhaust and supply side
E. Plates: Evenly spaced and sealed and arranged for counter airflow.
   1. Plate Material: Embossed aluminum Coatings are available for aluminum plates in corrosive atmospheres.
   2. Plate Coating: Epoxy

F. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.

G. Water Wash: Automatic system, with spray manifold to individual spray tubes or traversing type with stainless-steel-screw operating mechanism and electric motor drive; activated by time clock, with detergent injection.

H. Extended-Surface, Nonsupported-Media Filters:
   1. Comply with NFPA 90A.
   2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   5. Initial Resistance: 0.28 inches w.c.
   6. Recommended Final Resistance: 1.0 inches w.c.
   9. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent.
   11. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for pre-filter.

2.4 FIXED-PLATE TOTAL HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Mitsubishi Electric Sales Canada Inc.
2. RenewAire LLC.

C. Casing: Galvanized steel.

D. Plates: Evenly spaced and sealed and arranged for counter airflow.

   1. Plate Material: Chemically treated paper with selective hygroscopicity and moisture permeability, and gas barrier properties.

E. Bypass Plenum: Within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.

F. Extended-Surface, Disposable Panel Filters:

   1. Comply with NFPA 90A.
   2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
   5. Thickness 2 inches
   6. Initial Resistance: <0.25 inches wg.
   7. Recommended Final Resistance: <1.0 inches wg.
   9. Merv (ASHRAE 52.2): 7
   10. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.

2.5 PACKAGED ENERGY RECOVERY UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Des Champs Technologies.
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
5. RenewAire LLC.
6. SEMCO Incorporated.
7. Venmar CES Inc.
8. Wing, L. J.; Mestek Technology Inc.

B. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed and calked weathertight, hinged access doors removable panels with neoprene gaskets for inspection and access to internal parts, minimum 1-inch thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

1. Inlet: Weatherproof hood louver, with gravity backdraft damper for exhaust and spring-return, two-position, motor-operated damper with blade seals for supply.
2. Roof Curb: Refer to Division 07 Section "Roof Accessories" for roof curbs and equipment supports.

C. Heat Recovery Device: Heat wheel or Heat-pipe heat exchanger or Fixed-plate heat exchanger.

D. Supply and Exhaust Fans: Backward-inclined, plenum centrifugal fan with restrained, spring and insulated flexible duct connections.

1. Motor and Drive: Belt driven with adjustable sheaves, motor mounted on adjustable base.
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
5. Spring isolators on each fan having 1-inch static deflection.

E. Extended-Surface, Non-supported-Media Filters:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
5. Initial Resistance: 0.28 inches w.c.
6. Recommended Final Resistance: 1.0 inches wg.
7. Arrestance (ASHRAE 52.1): 95
8. MERV Efficiency: (ASHRAE 52.2): 14
9. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions and antimicrobial agent.
11. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for pre-filter.

F. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
3. Include non-fused disconnect switches.
4. Variable-speed controller to vary fan capacity from 100 to approximately 50 percent.

G. Accessories:

1. Roof Curb Galvanized steel with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 18 inches
2. Intake weather hood with 2-inch thick filters.
3. Louvered intake weather hood with 2-inch thick filters in V-bank configuration.
4. Exhaust weather hood with bird-screen.
5. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals, in parallel-blade arrangement with cadmium-plated steel operating rods rotating in sintered bronze bearings mounted in a single extruded-aluminum frame, with operating
rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 9 cfm/sq. ft. at 4-inch wg.

6. Duct flanges.
8. Hinged access doors with quarter-turn latches.
10. Automatic, in-place, spray-wash system.
11. Weatherproofing for tilt-control system.

2.6 CONTROLS

A. Time Clock: Solid-state, programmable, microprocessor-based unit for mounting in outdoor NEMA 250, Type 3R enclosure with up to eight on/off cycles per day and battery backup protection of program settings against power failure to energize unit.

B. Carbon Monoxide Sensor: Adjustable control from 600 to 2000 ppm for duct mounting with digital display and computer/building management system interface to energize unit.

C. Humidistat: Adjustable, wall-mounted instrument to energize unit when space relative humidity exceeds 70 percent

2.7 CAPACITIES AND CHARACTERISTICS

A. Exhaust Air:

1. Airflow: <Insert cfm>.
2. Face Velocity: <Insert fpm>.
3. Summer:
   a. Entering-Air Temperature, Dry Bulb: <Insert deg F>.
   c. Leaving-Air Temperature, Dry Bulb: <Insert deg F>.
   d. Leaving-Air Temperature, Wet Bulb: <Insert deg F>.
4. Winter:
   a. Entering-Air Temperature, Dry Bulb: <Insert deg F>.
   c. Leaving-Air Temperature, Dry Bulb: <Insert deg F>.
d. Leaving-Air Temperature, Wet Bulb: <Insert deg F>.

5. Air Pressure Drop: <Insert inches wg>.
7. Fan Motor Electrical Characteristics:
   a. Volts: 120 208 230 <Insert value>.
   b. Phase: Single Three.
   c. Hertz: 60.

B. Supply Air:
1. Airflow: <Insert cfm>.
2. Face Velocity: <Insert fpm>.
3. Summer:
   a. Entering-Air Temperature, Dry Bulb: <Insert deg F>.
   c. Leaving-Air Temperature, Dry Bulb: <Insert deg F>.
   d. Leaving-Air Temperature, Wet Bulb: <Insert deg F>.

4. Winter:
   a. Entering-Air Temperature, Dry Bulb: <Insert deg F>.
   c. Leaving-Air Temperature, Dry Bulb: <Insert deg F>.
   d. Leaving-Air Temperature, Wet Bulb: <Insert deg F>.

5. Air Pressure Drop: <Insert inches wg>.
7. Fan Motor Electrical Characteristics:
   a. Volts: 120 208 230 <Insert value>.
   b. Phase: Single Three.
   c. Hertz: 60.

C. Wheel Drive:
2. Motor Electrical Characteristics:
END OF SECTION 237200
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Constant-air-volume, single-zone air-handling units.
   2. Constant-air-volume, multi-zone air-handling units.
   3. Constant-air-volume, dual-duct air-handling units.
   4. Variable-air-volume, single-zone air-handling units.
   5. Variable-air-volume, dual-duct air-handling units.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. Comply with NFPA 70.

E. Provide factory leakage testing witnessed by owner and engineer.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each air-handling unit indicated.

   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Submit the family of rpm curves indicating operating point relative to fan class.
c. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.

d. Certified fan-sound power ratings.

e. Certified unit sound power levels at specified rating.

f. Fan construction and accessories.

g. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.

5. Dampers, including housings, linkages, and operators.

6. Filters with performance characteristics.

7. Ancillary manufacturer provided piping and equipment supports.

8. Drain pan configuration

9. Manufacturer’s provided piping

10. Manufacturer shall submit a line by line statement of compliance or non-compliance for each clause in this specification.

B. LEED Submittals:


2. Product Data for Credit EA 5: For continuous metering equipment for outdoor airflow and energy consumption.

C. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer

D. Source quality-control reports.

E. Factory quality-control and test reports.

F. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

G. Warranty
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Enterprise
   2. Buffalo Air Handling.
   3. Clima Craft
   4. Governaire
   5. YORK International Corporation (York Custom line)
   6. CES/Ventrol,
   7. Haakon
   8. LSB Industries

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:
   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   2. Casing Joints: Sheet metal screws or pop rivets.
   3. Sealing: Seal all joints with water-resistant sealant.
   4. The unit downstream of the cooling coil section shall be thermally broken
   5. Factory Finish for Steel and Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer’s standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
   6. Leakage rating shall be less than 1% at 12 inches of static pressure

B. Casing construction

   1. Outside Casing: Galvanized steel, minimum 0.064 inch thick.
   OR
   2. Outside Casing: Aluminum, minimum 0.080 inch thick.
   3. Inside Casing: Galvanized steel, solid minimum 0.052 inch thick.
   4. Floor Plate: Stainless steel, minimum 0.1094 thick.
   5. Insulation Thickness: 2 inches
   6. Static-Pressure Classifications for Unit Sections before Fans: 2-inch wg 3-inch wg 4-inch wg 6-inch wg 8-inch wg 9-inch wg 10-inch wg <Insert value>.
7. Static-Pressure Classifications for Unit Sections after Fans: 2-inch wg 3-inch wg 4-inch wg 6-inch wg 8-inch wg 9-inch wg 10-inch wg <Insert value>.
8. Provide ADD alternate for aluminum tread plate or diamond plate in the service corridor.
9. Provide ADD alternate for drainable floor sections in each section of the unit piped to the exterior (by the AHU manufacturer) to the outside of the casing.

C. Casing Insulation and Adhesive:
   1. Materials: ASTM C 1071, Type II.
   2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   3. Location and Application: Encased between outside and inside casing.

D. Inspection and Access Panels and Access Doors:
   1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
   2. Inspection and Access Panels:
      a. Fasteners: Two or more cam-lock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
      b. Gasket: Neoprene, applied around entire perimeters of panel frames.
      c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
   3. Access Doors:
      a. Hinges: A minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
      b. Gasket: Neoprene, applied around entire perimeters of panel frames.
      c. Fabricate windows in doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
d. Size: At least 24 by 60 inches.

4. Locations and Applications:
   a. Fan Section: Inspection and access panels Doors.
   b. Access Section: Doors.
   c. Coil Section: Inspection and access panel.
   d. Damper Section: Inspection and access panels Doors.
   e. Filter Section: Inspection and access panels Doors large enough to allow periodic removal and installation of filters.

5. Service Light: 100-W vapor-proof fixture in each section accessed with door, with switched junction box located outside adjacent to door.

E. Condensate Drain Pans:
   1. Fabricated with slopes in at least 2 planes to collect condensate from cooling coils (including coil piping connections, coil headers and return bends, and a minimum of 6 inches downstream from cooling-coil face) and from humidifiers.
   2. Integral part of floor plating.
   3. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
   4. A minimum of 2 inches deep, and complying with requirements in ASHRAE 62.1.
   5. Drain Connections: Both ends of pan with NPS 1 threaded nipple.
   6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

F. Service Platform: Steel 42 inches wide running entire length of suspended unit and located on service access side, with angle side rails, 4-inch kick plates, and expanded metal floor.

G. Air-Handling-Unit Mounting Frame: Structural channel supports, designed for low deflection, welded with integral lifting lugs.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when air-handling unit frame is anchored to building structure.
2. The floor shall be constructed of a full perimeter welded base frame with structural steel tubing, C-channel cross support members and an insulated double bottom floor. Caulk
and seal floor seams airtight. Structural unit base must be electrostatically primed. Formed galvanized steel unit bases will not be accepted.

H. Additional steel
1. Air handling units are to provided with integral or additional structural steel base to accommodate the additional height requirements for the cold and/or hot condensate piping discharge from the unit to raise the unit up to accommodate for trap height, pump inlet connection height and priming. Coordinate height requirements with field conditions.

I. AHU manufacturer to provide chilled water and steam piping and valve supports in casing.

J. All coils to be installed on racks for individual removal.

K. Provide motor track or rigging davits for all AHU motors.

2.3 FAN, DRIVE, AND MOTOR SECTION
System design considerations
Fans should be selected using a combination of the required airflow and the estimated (calculated) static pressure. Airflow and static pressure should be corrected for altitude and temperature; manufacturer's ratings are usually given at standard conditions. Inertial loads on startup for large fans may require special drive equipment or larger motors.

The specific service determines the type of fan selected. When operation occurs with little or no resistance, and particularly without a duct system, propeller fans are appropriate for convenience and low cost. If a duct system is involved, choose between centrifugal fans and tube-axial or vane-axial fans. Centrifugal and axial fans are comparable in efficiency and sound. Axial fans are lighter and smaller than centrifugal fans and may be less accessible for service.

Centrifugal fans: free-standing units in various configurations, including single-width, single inlet; double-width, double inlet; in-line; plenum and plug; suitable for general HVAC applications and usually applied to large, built-up systems.

2.4 GENERAL
A. Make appropriate allowances for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.

B. Fans shall be non-overloading and operate stably without surging at design conditions.

C. Fan characteristic curves provided by manufacturer must be such that the fan operating point:
1. Is to the right of peak efficiency.

2. Is on the steep part of the fan curve such that an increase in static pressure over the specified duty results in not more than the same percent decrease in volume (CFM) and does not affect the stability of fan operation.

3. Is no greater than 60 to 70 percent of the peak static pressure.

4. Has the ability to provide an allowable increase in fan speed of 15 percent above the design point without surging or increasing the class of fan.

D. Provide non-overloading design, except as noted with minimum capacities as noted and with certified ratings by AMCA. Where variable inlet vanes are used, complete assembly shall be factory installed by the fan manufacturer. The fan horsepower performance characteristics shall be within 5 percent of published catalog rating data of the standard fan without the variable inlet vanes, where no data is available for the fan with inlet vanes. Inlet vanes shall be capable of reducing flow to 20 percent of design cfm at 1-1/2 inch w.g. static pressure and maintain stable performance. Inlet vanes and all operating linkages shall be provided and assembled by fan manufacturer prior to shipment to job site.

E. Wheel shall be factory balanced statically and dynamically. Brake horsepower ratings shall be 5 percent maximum above those noted and published for a minimum of two (2) years.

F. Motor pulley shall be variable pitch diameter, for fans up to 25 hp and 1000 rpm, except fans with variable inlet vanes and VFD’s use fixed pitch, and fixed pitch diameter, over 25 hp or 1000 rpm. Supply and install one fixed pitch pulley change, as required, per fan to balance systems. Companion sheaves shall maintain belts parallel. Belt guards shall be in compliance with OSHA regulations and with tachometer opening for fan speed measurements. Manufacturer shall provide replacement fixed pitched sheaves where needed to balance system.

G. Provide removable flanged screens at inlets or outlets where no connecting ductwork is indicated, including inlets to fans in field erected casings.

H. Bearings shall be ball, roller or taper. Provide pressure type lubricating fittings with pressure relief fittings extended to accessible locations. Lubricating fittings shall be similar to Alemite. Pressure relief fittings shall be similar to Keystone. For fans 27 inch and larger, provide housings horizontally split, roller bearings.

I. Split construction: Provide split construction for fans too large for available doorways or passageways. Split in half along center of shaft with angles, etc., to allow removal of section without disturbing inlet and discharge connection; arranged for bolting. Provide bolts
with lock washers and nuts. Construction shall be inspected by manufacturer after field assembly and certified that they have been properly assembled and ready for proper operation.

J. The drive end of the fan shaft shall be countersunk for tachometer readings.

K. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower. Fans shall be capable of delivering the specified airflow while VFD is in "bypass" mode.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

L. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches 5-3/4 inches wide attached to 2 strips of 2-3/4-inch wide, 0.028-inch thick, galvanized-steel sheet or 0.032-inch thick aluminum sheets; select metal compatible with casing.
      1) Fabric Minimum Weight: 26 oz./sq. yd.
      2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

M. Plug Fans Housings: Steel cabinet; fabricated without fan scroll and volute housing.
N. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

O. Unhoused plenum fans: fan shall be SWSI arrangement-3 plenum fan, with airfoil blades welded to the wheel side plates. Include internal spring isolators for fans, motors and drive on a structural steel base complete with flex connection.

P. Fan Shaft Bearings:
   1. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 120,000 hours according to ABMA 11.
   2. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit, and a rated life of 120,000 hours according to ABMA 11.

Q. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
   1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   2. Belts: Oil resistant, non-sparking, and non-static; in matched sets for multiple-belt drives.
   3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

R. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 2 inches.

S. Retain subparagraph below for projects in seismic areas. If retaining, also retain "Seismic Qualification Certificates" Paragraph in "Submittals" Article.
   1. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.
New York Presbyterian Hospital  
Engineering Design Standards  
March, 2015

T. Motors
   1. Enclosure Type: Totally enclosed, fan cooled.
   2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
   4. Mount unit-mounted disconnect switches on interior of unit.

U. Variable Frequency Controllers:
   1. Refer to “Variable frequency controller” specification for requirements.
   2. Mount unit-mounted VFD’s on exterior of unit
   3. Provide as a packaged part of the unit
   4. Control Signal Interface:
      a. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

V. Provide single point power supply with all components (VFD, lighting, power receptacles) factory wired.

2.5 COIL SECTION

A. General Requirements for Coil Section:
   1. Comply with ARI 410.
   2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
   3. For multi-zone units, provide air deflectors and air baffles to balance airflow across coils.
   4. AHU manufacturer shall provide all individual piping to each coil within the unit casing refer to piping sections for all requirements.
   5. Coils shall not act as structural component of unit.
   6. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and..."
Seismic Controls for HVAC Piping and Equipment" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

B. Refer to section “AIR COILS “for all requirements.

2.6 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 AppendixJ. and ASHRAE 170.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Disposable Panel Filters:

1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness 2 inches.
3. Dust Spot Efficiency: 30%
4. Initial Resistance: 0.30 inches w.c.
5. Recommended Final Resistance: 0.70 inches w.c.
6. Arrestance (ASHRAE 52.1): 90%
7. Merv (ASHRAE 52.2): 8
9. Media-Grid Frame: Nonflammable high wet-strength beverage board frame with diagonal media support members
10. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

C. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, extended-surface type.
2. Dust Spot Efficiency: 30%
3. Thickness: 4 inches.
5. Initial Resistance: 0.27 inches w.c.
6. Recommended Final Resistance: 0.80 inches w.c.
7. Arrestance (ASHRAE 52.1): 90%
8. MERV Efficiency: (ASHRAE 52.2): 8
9. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
10. Media-Grid Frame: Nonflammable high wet-strength beverage board frame with diagonal media support members
11. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

D. Extended-Surface, Non-supported-Media Filters:

1. Factory-fabricated, dry, extended-surface, self-supporting type.
2. Dust Spot Efficiency: 95%
3. Initial Resistance: 0.30 ins. w.c.
4. Recommended Final Resistance: 1.0 inches w.c.
5. Arrestance: (ASHRAE 52.1): 98%
6. MERV Efficiency: (ASHRAE 52.2): 14
7. Media: Fibrous material with antimicrobial agent constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.
9. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for pre-filter.

E. Activated-Carbon Panel Filters:

1. Factory-fabricated unit with activated-carbon media.
2. Flat-Panel Media: Multilayer filter with inlet layer of polyester fibers, layer of activated-carbon granules bonded to fibers, layer of polyurethane foam, and housed in cardboard frame.
3. Pleated Media: Multilayer filter with inlet layer of cotton and synthetic fibers and layer of activated-carbon granules bonded to synthetic fibers, formed into deep-V-shaped pleats and held by self-wire grid, and housed in nonflammable cardboard frame.
4. Mounting Frames: Welded galvanized steel, with polyurethane gaskets and fasteners, capable of holding media and media frame in place and suitable for bolting together into built-up filter banks.

F. Activated-Carbon Filters:

1. Factory-fabricated unit in deep-V arrangement with disposable panel prefilter.


4. Housing: 0.064-inch thick, galvanized steel, for side servicing through gasketed access doors on both sides. Equip housings with metal slide channel tracks to hold activated-carbon trays.

G. HEPA Filters:

1. Factory-fabricated unit.
2. MERV Efficiency: (ASHRAE 52.2) 17.
3. Initial Resistance: 1.20 inches w.c.
4. Recommended Final Resistance: 2.5 inches wg>.
5. Arrestance: (ASHRAE 52.1) 99.97 percent on 0.3-micrometer D.O.P. particles
8. Media to Frame Side Bond: Thermosetting sealant
9. Face Gasket: Neoprene expanded rubber
10. Mounting Frames: Downstream corners of holding device shall have cushion pads to protect media. Bolted filter-sealing mechanism shall mount and continuously seal each individual filter.

H. Filter Gage:

1. 2-inch- diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 3.0-inch w.c.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.7 DAMPERS

A. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

1. Size dampers for running torque calculated as follows:
b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

2. Coupling: V-bolt and V-shaped, toothed cradle.
3. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
4. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on non-spring-return actuators.
5. Power Requirements (Two-Position Spring Return): 24 V ac.
6. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
7. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
8. Temperature Rating: Minus 22 to plus 122 deg F
9. Run Time: 12 seconds open, 5 seconds closed

B. Pneumatic Damper Operators:

1. Rolling-diaphragm piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Where actuators operate in sequence, provide pilot positioners.
2. Pneumatic Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.
3. Pilot Positioners:
   a. Start Point: Adjustable from 2 to 12 psig.
   b. Operating Span: Adjustable from 5 to 13 psig.
   c. Linearity: Plus or minus 10 percent of output signal span.
   d. Hysteresis: 3 percent of span.
   e. Response: 0.25-psig input change.
   g. Maximum Control Air-Supply Pressure: 60 psig.
4. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140 deg F unless located in return-air plenums.
5. Inlet-Vane Operators: High pressure, with pilot positioners.

C. Zone Dampers: Two single-blade, extruded-aluminum dampers offset 90 degrees from each other on cadmium-plated steel operating rod rotating in sintered bronze or nylon bearings mounted in a extruded-aluminum frame. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

D. Face-and-Bypass Dampers: Opposed-blade, extruded-aluminum dampers with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single extruded-aluminum frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.

E. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, extruded-aluminum dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

F. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single extruded-aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

G. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

H. Combination Filter and Mixing Section:
   1. Cabinet support members shall hold 2-inch thick, pleated, flat, permanent or throwaway filters.
   2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

I. Outside air measuring dampers
   1. Provide low leakage Ruskin dampers and Ruskin IAQ50 on outside air, AMCA approved. The dampers shall be made of extruded aluminum air foil blades, extruded EPDM blade gaskets, extruded TPE frame seals, 7/16" aluminum hexagon shaft, aluminum linkage crankarm and pivot pin, acetal copolymer inner bearing and polycarbonate outer bearing and a 12 gauge aluminum frame. Provide air straighter.
2. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

2. Provide low leakage Ruskin dampers on outside air with a thermal dispersion measurement system (Ebtron), AMCA approved. The dampers shall be made of extruded aluminum air foil blades, extruded EPDM blade gaskets, extruded TPE frame seals, 7/16" aluminum hexagon shaft, aluminum linkage crankarm and pivot pin, acetal copolymer inner bearing and polycarbonate outer bearing and a 12 gauge aluminum frame. Provide air straighter.

a. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

2.8 HUMIDIFIERS

A. Steam Grid Humidifier:

1. Manifold:
   a. ASTM A 666, Type 304 stainless steel.
   b. Steam jacketed.
   c. Insulated with 1/2-inch fiberglass and stainless-steel jacket.
   d. Manifold shall extend the full width of unit with mounting brackets at ends.

2. Steam Separator: ASTM A 666, Type 304 stainless steel, with separate humidifier control valve.


4. Steam Trap: Inverted-bucket type, sized for a minimum of three times the maximum rated condensate flow of humidifier at 1/2-psig inlet pressure.

5. Aquastat: For separate mounting on steam condensate, return piping to prevent cold operation of humidifier.


7. Airflow Switch: To prevent humidifier operation in the absence of airflow.

2.9 AIR-TO-AIR ENERGY RECOVERY

A. Retain this article to require that air-to-air energy recovery units be provided by air-handling unit manufacturer; delete if air-to-air energy recovery units are specified in Division 23 Section "Air-to-Air Energy Recovery Equipment." Heat Wheels:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Loren Cook Company.
   b. SEMCO Incorporated.

2. Casing:
   a. Steel, with manufacturer’s standard paint coating.
   b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
   c. Casing seals on periphery of rotor, on duct divider, and on purge section.
   d. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.


4. Drive: Fractional horsepower motor and gear reducer with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.

5. Controls:
   a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
   b. Variable frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
   d. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

B. Fixed-Plate Sensible Heat Exchangers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
b. Des Champs Technologies.
c. Exothermics Inc.; a brand of Eclipse, Inc.
d. Nutech Brands Inc.
e. RenewAire LLC.

3. Casing: Galvanized steel
4. Plates: Evenly spaced and sealed and arranged for counter airflow.
5. Plate Material: Embossed aluminum
   a. Plate Coating: Epoxy

6. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
7. Water Wash: Automatic system, with spray manifold to individual spray tubes or traversing type with stainless-steel-screw operating mechanism and electric motor drive; activated by time clock, with detergent injection.
8. Heat-Exchanger Prefilters: 2 inches thick, disposable Medium efficiency

2.10 CAPACITIES AND CHARACTERISTICS

A. Casing:
   1. Outside Casing: Galvanized steel, minimum 0.064 inch thick.
   2. Inside Casing: Galvanized steel, solid, minimum 0.052 inch thick.
   3. Floor Plate: Galvanized steel, minimum 0.079 inch thick.
   4. Insulation Thickness 2 inches
   5. Static-Pressure Classifications for Unit Sections before Fans: 6-inch wg
   6. Static-Pressure Classifications for Unit Sections after Fans 10-inch wg

B. Supply Fan:
   2. Drive: V-belt or Direct.
   3. Type: Steel, airfoil centrifugal
   4. Number of Fan Wheels: <Insert number>.
   5. Fan Diameter : <Insert inches>.
   6. Fan Housing and Wheel Coating Powder-baked enamel
   8. Total Static Pressure: <Insert inches wg>.
  10. Speed: <Insert rpm>.
12. Inlet vane controls.
15. Electrical Characteristics:
   a. Volts: 120 208 230 <Insert value>.
   b. Phase: Single Three.
   c. Hertz: 60.
   d. Full-Load Amperes: <Insert value>.
   e. Minimum Circuit Ampacity: <Insert value>.
   f. Maximum Overcurrent Protection: <Insert amperage>.
16. Fan Discharge Sound Power:
   a. 1st Octave: <Insert value>.
   b. 2nd Octave: <Insert value>.
   c. 3rd Octave: <Insert value>.
   d. 4th Octave: <Insert value>.
   e. 5th Octave: <Insert value>.
   f. 6th Octave: <Insert value>.
   g. 7th Octave: <Insert value>.
   h. 8th Octave: <Insert value>.
C. Return Fan:
2. Drive: V-belt or Direct.
3. Type: Steel, airfoil centrifugal
4. Number of Fan Wheels: <Insert value>.
5. Fan Diameter: <Insert inches>.
6. Fan Housing and Wheel Coating: Powder-baked enamel
8. Total Static Pressure: <Insert inches wg>.
10. Speed: <Insert rpm>.
12. Inlet vane controls.
15. Electrical Characteristics:
a. Volts: 120 208 230 <Insert value>.
b. Phase: Single Three.
c. Hertz: 60.
d. Full-Load Amperes: <Insert value>.
e. Minimum Circuit Ampacity: <Insert value>.
f. Maximum Overcurrent Protection: <Insert amperage>.

D. Preheat Coil:

1. Heat-Transfer Rate: <Insert Btu/h>.
2. Entering-Air Temperature: <Insert deg F>.
3. Leaving-Air Temperature: <Insert deg F>.
4. Face Area: <Insert sq. ft.>.
5. Maximum Face Velocity: <Insert fpm>.
7. Coil Type: Steam distributed
8. Piping Connections Flanged same end of coil.
9. Tube Material: Copper
10. Fin Type: Plate
11. Fin Material: Aluminum
12. Fin Spacing: 0.125 inch inch
13. Fin and Tube Joint: Mechanical bond
14. Headers:
   a. Cast iron with cleaning plugs and drain and air vent tappings extended to exterior of unit.
   b. Seamless copper tube with brazed joints, prime coated.
   c. Fabricated steel, with brazed joints, prime coated.
   d. Provide insulated cover to conceal headers exposed outside casings.
15. Frames: 0.079-inch- thick galvanized steel
16. Number of Rows: <Insert number>.
17. Coil Working-Pressure Ratings: 200 psig, 325 deg F <Insert value>.
18. Water:
   b. Maximum Water Pressure Drop: <Insert feet of head>.
   c. Entering-Water Temperature: <Insert deg F>.
   d. Leaving-Water Temperature: <Insert deg F>.
19. Steam:
a. Steam Flow: <Insert lb/h>.
b. Inlet Steam Pressure: <Insert psig>.
c. Outer-Tube Diameter: <Insert inches>.

20. Coating: Powder-baked enamel
21. Integral Face-and-Bypass Dampers: Vertical, opposed-blade, extruded-aluminum dampers with cadmium-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single extruded-aluminum frame, with operating rods connected with a common linkage. Meeting edges of blades shall have gaskets and edge seals, and blades shall be mechanically fastened.

E. Heating Coil:

1. Heat-Transfer Rate: <Insert Btu/h>.
2. Entering-Air Temperature: <Insert deg F>.
3. Leaving-Air Temperature: <Insert deg F>.
4. Face Area: <Insert sq. ft.>.
5. Maximum Face Velocity: <Insert fpm>.
7. Coil Type Cleanable
8. Coil Type: Steam distributed
10. Tube Material: Copper
11. Fin Type: Plate.
12. Fin Material: Aluminum.
13. Fin Spacing: 0.091 inch
14. Fin and Tube Joint: Mechanical bond
15. Headers:
   a. Cast iron with cleaning plugs and drain and air vent tappings extended to exterior of unit.
   b. Seamless copper tube with brazed joints, prime coated.
   c. Fabricated steel, with brazed joints, prime coated.
   d. Provide insulated cover to conceal headers exposed outside casings.
16. Frames: Channel frame, 0.079-inch- thick galvanized steel
17. Number of Rows: <Insert number>.
18. Coil Working-Pressure Ratings: 200 psig, 325 deg F
19. Water:
b. Maximum Water Pressure Drop: <Insert feet of head>.
c. Entering-Water Temperature: <Insert deg F>.
d. Leaving-Water Temperature: <Insert deg F>.

20. Steam:
   a. Steam Flow: <Insert lb/h>.
   b. Inlet Steam Pressure: <Insert psig>.
   c. Outer-Tube Diameter: <Insert inches>.

21. Coating: Powder-baked enamel

F. Electric Heating Coil:
   1. Heat-Transfer Rate: <Insert Btu/h>.
   2. Input: <Insert kilowatts>.
   3. Volts: 120 208 230 <Insert value>.
   5. Full-Load Amperes: <Insert value>.
   6. Number of Steps: <Insert number>.

G. Cooling Coil:
   1. Sensible Heat-Transfer Rate: <Insert Btu/h>.
   2. Total Heat-Transfer Rate: <Insert Btu/h>.
   5. Leaving-Air, Dry-Bulb Temperature: <Insert deg F>.
   7. Face Area: <Insert sq. ft.>.
   10. Number of Rows: <Insert number>.
   11. Fin Type: Plate
   12. Fin Spacing: <Insert fins per inch>.
   13. Coil Working-Pressure Ratings: 200 psig, 325 deg F
   14. Water:
      b. Maximum Water Pressure Drop: <Insert feet of head>.
      c. Entering-Water Temperature: <Insert deg F>. 
d. Leaving-Water Temperature: <Insert deg F>.

15. Refrigerant Type: <Insert type>.
16. Coating: Powder-baked enamel

H. Prefilters:

1. Type: <Insert type>.
2. Face Area: <Insert sq. ft.>.
4. Thickness or Depth: <Insert inches>.
5. Number of Filters: <Insert number>.
7. Maximum or Rated Face Velocity: <Insert fpm>.

I. Filters:

1. Type: <Insert type>.
2. Face Area: <Insert sq. ft.>.
4. Thickness or Depth: <Insert inches>.
5. Number of Filters: <Insert number>.
7. Maximum or Rated Face Velocity: <Insert fpm>.

J. Dampers: Zone Mixing dampers Face and bypass.

K. Steam Grid Humidifier:

1. Humidification Rate: <Insert lb/h>.
2. Steam Supply Pressure: <Insert psig>.
3. Dry-Bulb Air Temperature at Discharge: <Insert deg F>.
4. Wet-Bulb Air Temperature at Discharge: <Insert deg F>.
5. Maximum Absorption Distance: <Insert inches>.
6. Number of Manifolds: <Insert number>.

L. Wet Glass Cell Washer:

1. Rated Capacity: <Insert lb/h>.
2. Saturation Efficiency: <Insert percent>.

M. Evaporative Humidifier:
1. Rated Capacity:  <Insert lb/h>.
2. Saturation Efficiency:  <Insert percent>.

N. Air-to-Air Energy Recovery:

1. Exhaust Air:
   a. Airflow:  <Insert cfm>.
   b. Face Velocity:  <Insert fpm>.
   c. Summer:
      1) Entering-Air Temperature, Dry Bulb:  <Insert deg F>.
      2) Entering-Air Temperature, Wet Bulb:  <Insert deg F>.
      3) Leaving-Air Temperature, Dry Bulb:  <Insert deg F>.
      4) Leaving-Air Temperature, Wet Bulb:  <Insert deg F>.
   d. Winter:
      1) Entering-Air Temperature, Dry Bulb:  <Insert deg F>.
      2) Entering-Air Temperature, Wet Bulb:  <Insert deg F>.
      3) Leaving-Air Temperature, Dry Bulb:  <Insert deg F>.
      4) Leaving-Air Temperature, Wet Bulb:  <Insert deg F>.
   e. Air Pressure Drop:  <Insert inches wg>.

2. Supply Air:
   a. Airflow:  <Insert cfm>.
   b. Face Velocity:  <Insert fpm>.
   c. Summer:
      1) Entering-Air Temperature, Dry Bulb:  <Insert deg F>.
      2) Entering-Air Temperature, Wet Bulb:  <Insert deg F>.
      3) Leaving-Air Temperature, Dry Bulb:  <Insert deg F>.
      4) Leaving-Air Temperature, Wet Bulb:  <Insert deg F>.
   d. Winter:
      1) Entering-Air Temperature, Dry Bulb:  <Insert deg F>.
      2) Entering-Air Temperature, Wet Bulb:  <Insert deg F>.
      3) Leaving-Air Temperature, Dry Bulb:  <Insert deg F>.
      4) Leaving-Air Temperature, Wet Bulb:  <Insert deg F>.
e. Air Pressure Drop: <Insert inches wg>.

3. Wheel Drive:
   b. Motor Electrical Characteristics:
      1) Volts: 120 208 230 <Insert value>.
      2) Phase: Single Three.
      3) Hertz: 60.


2.11 ULTRA-VIOLET (UV) LIGHT SECTION

A. General Requirements for UV-Light Sections:
   1. UV-C light fixtures and lamps shall be provided by the air handler manufacturer. The UV-C fixtures shall be factory-assembled and tested in the air handler. Field-installed fixtures shall not be allowed.

   2. UV Fixtures to meet UL Standards 153, 1598 & 1995

   3. The UV-C fixtures and lamps shall be coupled end-to-end and mounted on a slide-out rack to enable complete replacement and/or maintenance of the bulbs from the unit exterior.

   4. Voltage for lamps / transformers: 120V.

   5. MC to provide unit mounted control panel housing: fuses, contactors, relays and wiring.

B. Protection of Polymeric Materials
   1. All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be tested and certified as UV-C tolerant. Any polymeric material in direct or indirect contact with UV-C light not certified as UV-C tolerant shall be completely shielded from the UV-C light using a certified UV-C tolerant material such as metal. UV-C tolerance is defined as being capable of performing its intended duty for a minimum of 20 years.
C. Safety

1. Access doors shall be provided at the location of each UV-C light as indicated on the plans and schedule. All sections of the air handler with access doors where the UV-C lights may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door is opened.

2. In addition to the mechanical interlock switch, each unit shall be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the UV-C lights. The switch shall be equipped with a lock-out/tag-out to prevent unwanted operation of the UVC lights.

3. A view port with cover shall be provided in each UV section to allow viewing of the UV-C light array confirming operation. The view port and other AHU windows shall be treated to assure the UV-C energy emitted through it is below the threshold limits specified by NIOSH and ACGIH.

4. Units shall have a safety warning label applied to the exterior of each section containing UVC lights.

5. Complete safety, maintenance and servicing instructions for the UV-C lights and fixtures shall be incorporated into the air handler manufacturer’s standard installation, operating and maintenance manuals.

2.12

2.13 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.
D. Steam Coils: Factory tested to 300 psig and to 200 psig underwater according to ARI 410 and ASHRAE 33.

E. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

END OF SECTION 237313
PACKAGED, OUTDOOR, CENTRAL-STATION AIR-CONDITIONING UNITS
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
3. Hot-gas reheat.
4. Electric-heating coils.
5. Gas furnace.
6. Economizer outdoor- and return-air damper section.
7. Integral, space temperature controls.
8. Roof curbs.

1.2 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

D. Electrical Components, Devices, and Accessories: listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
   a. Certified fan-performance curves with system operating conditions indicated.
   b. Submit the family of rpm curves indicating operating point relative to fan class.
   c. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.
   d. Certified fan-sound power ratings.
   e. Certified unit sound power levels at specified rating.
   f. Fan construction and accessories.
   g. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.
7. Ancillary manufacturer provided piping and equipment supports.
8. Drain pan configuration

B. LEED Submittals:

1. Product Data for Credit EA 4: For refrigerants, including printed statement that refrigerants are free of HCFCs.
2. Product Data for Credit EA 5: For continuous metering equipment for outdoor airflow and energy consumption.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


D. Manufacturer Wind Loading Qualification Certification
E. Manufacturer Seismic Qualification Certification

F. Factory quality-control and test reports.

G. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Enterprise
2. Buffalo
3. Clima Craft
4. Governaire
5. Ventrol
6. YORK International Corporation.
7. LSB Industries

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.0626 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel solid 0.052 inch thick
New York Presbyterian Hospital
Engineering Design Standards
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D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 2 inch
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple both sides of drain pan.

F. The outdoor unit shall include a maintenance vestibule and shall be of the same construction noted above and shall include roof panels, cross broken and pitched for drainage with standing seams and mechanical seals. Access doors shall be fitted with drain gutters. Include (3) GFI receptacles wired from the unit power supply panel. Finish exterior panels with an industrial air-dried alkyd enamel.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, backward inclined, centrifugal; with permanently lubricated, single speed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

OR

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Backward inclined, shaft mounted on permanently lubricated motor.

E. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section
components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

F. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:
   1. Aluminum plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
   2. Coil Split: Interlaced.
   3. Condensate Drain Pan Stainless steel formed with pitch and drain connections complying with ASHRAE 62.

B. Outdoor-Air Refrigerant Coil:
   1. Aluminum plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.

C. Hot-Gas Reheat Refrigerant Coil:
   1. Aluminum plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.

D. Electric-Resistance Heating:
   1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
   2. Over temperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
   3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
   4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
a. Magnetic contactors.
b. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
c. Time-delay relay.
d. Airflow proving switch.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits Two Verify availability of crankcase heater in first paragraph below with manufacturer.

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant Charge: R-407C or R-410A
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
5. Automatic-reset low-pressure safety switch.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.6 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: Minimum 90 percent arrestance, and MERV 7.
2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
   1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel with a minimum thermal efficiency of 80 percent.
   1. Fuel: Natural gas.
   2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.

E. Safety Controls:
   1. Gas Control Valve: Modulating.

2.8 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
   1. Damper Motor: Modulating with adjustable minimum position.
   2. Relief-Air Damper: Gravity actuated with bird screen and hood.

2.9 ULTRA-VIOLET (UV) LIGHT SECTION

A. General Requirements for UV-Light Sections:
   1. UV-C light fixtures and lamps shall be provided by the air handler manufacturer. The UV-C fixtures shall be factory-assembled and tested in the air handler. Field-installed fixtures shall not be allowed.
2. UV Fixtures to meet UL Standards 153, 1598 & 1995

3. The UV-C fixtures and lamps shall be coupled end-to-end and mounted on a slide-out rack to enable complete replacement and/or maintenance of the bulbs from the unit exterior.

4. Voltage for lamps / transformers: 120V.

5. MC to provide unit mounted control panel housing: fuses, contactors, relays and wiring.

B. Protection of Polymeric Materials
   1. All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be tested and certified as UV-C tolerant. Any polymeric material in direct or indirect contact with UV-C light not certified as UV-C tolerant shall be completely shielded from the UV-C light using a certified UV-C tolerant material such as metal. UV-C tolerance is defined as being capable of performing its intended duty for a minimum of 20 years.

C. Safety
   1. Access doors shall be provided at the location of each UV-C light as indicated on the plans and schedule. All sections of the air handler with access doors where the UV-C lights may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door is opened.

   2. In addition to the mechanical interlock switch, each unit shall be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the UV-C lights. The switch shall be equipped with a lock-out/tag-out to prevent unwanted operation of the UVC lights.

   3. A view port with cover shall be provided in each UV section to allow viewing of the UV-C light array confirming operation. The view port and other AHU windows shall be treated to assure the UV-C energy emitted through it is below the threshold limits specified by NIOSH and ACGIH.

   4. Units shall have a safety warning label applied to the exterior of each section containing UVC lights.
5. Complete safety, maintenance and servicing instructions for the UV-C lights and fixtures shall be incorporated into the air handler manufacturer’s standard installation, operating and maintenance manuals.

2.10

2.11 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."

B. Basic Unit Controls:

1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Concealed set point.
   g. Concealed indication.
   h. Degree F indication.
   i. Unoccupied-period-override push button.
   j. Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.

3. Wall-mounted humidistat or sensor with the following features:
   a. Concealed set point.
   b. Concealed indication.
4. Unit-Mounted Annunciator Panel for Each Unit:
   a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
   b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
   c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

C. Electronic DDC Controller:
   1. Controller shall have volatile-memory backup.
   2. Safety Control Operation:
      a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
      b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
      c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 Section "Fire Detection and Alarm."
      d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F Retain first subparagraph below for air-to-air heat-pump feature.
      e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
   3. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
   4. Unoccupied Period:
      a. Heating Setback: 10 deg F
      c. Override Operation: Two hours.
   5. Supply Fan Operation:
      a. Occupied Periods: Run fan continuously.
      b. Unoccupied Periods: Cycle fan to maintain setback temperature.
6. Refrigerant Circuit Operation:
   a. Occupied Periods: Cycle or stage compressors and operate hot-gas bypass to match compressor output to cooling load to maintain room discharge temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
   b. Unoccupied Periods: Compressors off. Cycle compressors and condenser fans for heating to maintain setback temperature.
   c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.

7. Hot-Gas Reheat-Coil Operation:
   a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
   b. Unoccupied Periods: Reheat not required.

8. Gas Furnace Operation:
   a. Occupied Periods: Modulate burner to maintain room discharge temperature.
   b. Unoccupied Periods: Cycle burner to maintain setback temperature.

9. Electric-Heating-Coil Operation:
   a. Occupied Periods: Modulate coil to maintain room discharge temperature.
   b. Unoccupied Periods: Energize coil to maintain setback temperature.
   c. Operate supplemental electric heating coil with compressor for heating with outdoor temperature below 25 deg F.

10. Fixed Minimum Outdoor-Air Damper Operation:
    a. Occupied Periods: Open to 25 percent.
    b. Unoccupied Periods: Close the outdoor-air damper.

11. Economizer Outdoor-Air Damper Operation:
    a. Occupied Periods: Open to 25 percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
c. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc or 4 to 20 mA

12. Carbon Dioxide Sensor Operation:
   a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
   b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

13. VVT Relays:
   a. Provide heating- and cooling-mode changeover relays compatible with WT terminal control system required in Division 23 Sections "Air Terminal Units" and "Instrumentation and Control for HVAC."

D. Interface Requirements for HVAC Instrumentation and Control System:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
   3. Provide Bacnet or Lon Works compatible interface for central HVAC control workstation for the following:
      a. Adjusting set points.
      b. Monitoring supply fan start, stop, and operation.
      c. Inquiring data to include outdoor-air damper position supply- and room-air temperature and humidity.
      d. Monitoring occupied and unoccupied operations.
      e. Monitoring constant and variable motor loads.
      f. Monitoring variable-frequency drive operation.
      g. Monitoring cooling load.
      h. Monitoring economizer cycles.
      i. Monitoring air-distribution static pressure and ventilation air volume.

2.13 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.
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B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

C. Low-ambient kit using variable-speed condenser fans for operation down to 35 deg F

D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

E. Coil guards of painted, galvanized-steel wire.

2.14 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   
a. Materials: ASTM C 1071, Type I or II.
   
b. Thickness: 2 inches

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   
a. Liner Adhesive: Comply with ASTM C 916, Type I.
   
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
   
d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: 18 inches

D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.
Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

2.15 CAPACITIES AND CHARACTERISTICS

A. Supply-Air Fan:
   1. Airflow: <Insert cfm>.
   2. External Static Pressure: <Insert inches wg>.
   3. Fan Speed: <Insert rpm>.
   5. Motor Speed: <Insert rpm>.

B. Relief-Air Fan:
   1. Airflow: <Insert cfm>.
   2. External Static Pressure: <Insert inches wg>.
   3. Fan Speed: <Insert rpm>.
   5. Motor Speed: <Insert rpm>.

C. Outdoor-Air-Intake Relief-Air Fan:
   1. Airflow: <Insert cfm>.
   2. Static Pressure: <Insert inches wg>.
   3. Fan Speed: <Insert rpm>.
   5. Motor Speed: <Insert rpm>.

D. Supply-Air Refrigerant Coil:
   1. Total Cooling Capacity: <Insert Btu/h>.
   2. Sensible Cooling Capacity: <Insert Btu/h>.
   5. Coating: Baked phenolic Cathodic epoxy.

E. Outdoor-Air Refrigerant Coil:
   1. Ambient-Air Temperature: <Insert deg F>.
2. Coating: Baked phenolic Cathodic epoxy.
3. Fan Motor: <Insert value>.
4. Number of Fans: <Insert number>.

F. Hot-Gas Reheat Coil:
1. Heating Capacity: <Insert Btu/h>.
2. Entering-Air Temperature: <Insert deg F>.

G. Electric-Resistance Heating Coil:
2. Number of Steps: <Insert number>.

H. Compressors:
5. Coefficient of Performance (COP): <Insert value>.

I. Gas Furnace:
1. Airflow: <Insert cfm>.
2. Input: <Insert Btu/h>.
3. Output: <Insert Btu/h>.

J. Recirculating-Air Filters:
1. Minimum Face Area: <Insert sq. ft.>.
2. Thickness: 1 inch 2 inches <Insert thickness>.

K. Outdoor-Air Filters:
1. Minimum Face Area: <Insert sq. ft.>.
2. Thickness: 2 inches
3. Initial Resistance: 0.30 inches w.c.
4. Final Resistance: 0.7 inches w.c.

L. Electrical Characteristics for Single-Point Connection:

1. Voltage: <Insert value>.
2. Phase: <Insert value>.
3. Hertz: <Insert value>.
5. Minimum Circuit Ampacity: <Insert value>.

M. Sound Power: Radiated from condenser casing.

1. 1st Octave: <Insert value> dB.
2. 2nd Octave: <Insert value> dB.
3. 3rd Octave: <Insert value> dB.
4. 4th Octave: <Insert value> dB.
5. 5th Octave: <Insert value> dB.
6. 6th Octave: <Insert value> dB.
7. 7th Octave: <Insert value> dB.
8. 8th Octave: <Insert value> dB.

END OF SECTION 237413
PACKAGED, OUTDOOR, HEATING AND COOLING
MAKEUP AIR CONDITIONERS
SECTION 237433 - PACKAGED, OUTDOOR, HEATING AND COOLING MAKEUP AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes cooling-only and heating rooftop replacement-air units.

1.2 QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop replacement-air units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Units shall be designed to operate with HCFC-free refrigerants.

1.3 FACILITY OPERATIONS REQUIREMENTS
A. Product Data: Include rated capacities, furnished specialties, and accessories.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
   a. Certified fan-performance curves with system operating conditions indicated.
   b. Submit the family of rpm curves indicating operating point relative to fan class.
   c. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.
   d. Certified fan-sound power ratings.
   e. Certified unit sound power levels at specified rating.
   f. Fan construction and accessories.
g. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.
7. Ancillary manufacturer provided piping and equipment supports.
8. Drain pan configuration
9. Roof curbs and unit base construction

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:

1. Design Calculations: For selecting and designing restrained vibration isolation roof-curb rails.
2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

C. Startup service reports.

D. Operation and Maintenance Data: For rooftop replacement-air units to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

F. LEED Submittals:

1. Credit EA 4: Manufacturers’ product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.2 CABINET

A. Construction: Double wall.

B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.

C. Interior Casing: Galvanized steel.

D. Base Rails: Galvanized steel rails for mounting on roof curb.

E. Service Doors: Hinged access doors with neoprene gaskets.

F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.
   1. Thickness: 2 inches.
   2. Insulation Adhesive: Comply with ASTM C 916, Type I.
   3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

G. Condensate Drain Pans: Formed sections stainless-steel sheet designed for self-drainage. Fabricate pans with slopes to preclude buildup of microbial slime.

H. Roof Curb: Full-perimeter curb of sheet metal, minimum 16 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

I. The outdoor unit shall include a maintenance vestibule and shall be of the same construction noted above and shall include roof panels, cross broken and pitched for drainage with standing seams and mechanical seals. Access doors shall be fitted with drain gutters. Include (3) GFI receptacles wired from the unit power supply panel. Finish exterior panels with an industrial air-dried alkyd enamel.
2.3 SUPPLY-AIR FAN

A. Fan: backward-curved centrifugal; statically and dynamically balanced, galvanized steel, mounted on solid-steel shaft with pillow-block bearings rated L₁₀ for 120,000 hours and having external grease fittings.

B. Motor: Totally-enclosed, single speed motor.

C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.

D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained, isolators.

2.4 REFRIGERATION SYSTEM

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and over-temperature protection, internal pressure relief, and crankcase heater.


D. Refrigerant: R-407C or R-410A Refrigeration System Specialties:
   1. Expansion valve with replaceable thermostatic element.
   2. Refrigerant dryer.
   3. High-pressure switch.
   4. Low-pressure switch.
   5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
   6. Brass service valves installed in discharge and liquid lines.
   7. Operating charge of refrigerant.

E. Capacity Control: Patented, Rawal APR control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
F. Refrigerant Coils: Evaporator and condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.

1. Capacity Reduction: Circuit coils for interleaved control.
2. Tubes: Copper.
3. Fins: Aluminum with minimum fin spacing of 0.09 inch.
5. Suction and Distributor: Seamless copper tube with brazed joints.
6. Source Quality Control: Test to 450 psig, and to 300 psig underwater.

G. Condenser Fan: Propeller type, directly driven by motor.

H. Safety Controls:

1. Compressor motor and outside-coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.5 DIRECT-FIRED GAS FURNACE


B. Burners: Cast-iron burner with stainless-steel mixing plates.

1. Rated for a maximum turndown ratio of 30:1.

C. Safety Controls:

1. Gas manifold safety switches and controls shall comply with ANSI standards and FMG.
3. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
4. External gas-pressure regulator shall regulate pressure to not more than 0.5 psig.
5. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.


7. Gas Train: Redundant, main gas valves, electric pilot valve, main and pilot gas-pressure regulators, main and pilot manual shutoff valves, main and pilot pressure taps, and high-low gas-pressure switches to comply with FMG requirements.

2.6 INDIRECT-FIRED GAS FURNACE


1. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners: Stainless steel with a minimum thermal efficiency of 80 percent.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark with flame sensor.

C. Heat-Exchanger Drain Pan: Stainless steel.

D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.

E. Safety Controls:

1. Gas Control Valve: Electronic modulating.

2.7 ELECTRIC-RESISTANCE HEATING

A. Electric-Resistance Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
1. Heating Capacity: Low density 35 W per sq. in., factory wired for single-point wiring connection; with time delay for element staging, and overcurrent and overheat protective devices.

2. Safety Controls:
   a. Blower-motor interlock, air-pressure switch.
   b. Quiet mercury contactors.
   c. Time delay between steps.
   d. Integral, non-fused power disconnect switch.

2.8 HEATING COILS

A. Steam Coils: Distributing coil fabricated and tested according to ARI 410, with threaded steam supply and condensate connections. Non-freeze type having aluminum-plate fin and seamless copper double tube in galvanized-steel casing, pitched for proper drainage; tested to 150 psig and leak tested to 100 psig with air under water.

   1. Control valves are specified in Division 23 Section "Instrumentation and Control for HVAC."

2.9 COOLING COILS

A. Chilled-Water Coils: Cleanable coil fabricated and tested according to ARI 410 with aluminum fins and seamless copper tube stainless-steel casing.

   1. Control valves are specified in Division 23 Section "Instrumentation and Control for HVAC."

2.10 OUTDOOR-AIR INTAKE AND DAMPERS

A. Damper: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.

B. Damper Operators: Electric.

C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.
D. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen and finish to match cabinet.

2.11 FILTERS

A. Comply with NFPA 90A.

B. Disposable Panel Filters: 2-inch-thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.

1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
2. Frame: Galvanized steel.

2.12 CONTROLS

A. Factory-wire connection for controls’ power supply.

B. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer’s standard items to accomplish indicated control functions.

C. Unit Controls: Solid-state control board and components with field-adjustable control parameters.

D. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.

1. Timer: Seven-day electronic clock.
2. Electrically interlock kitchen hood fire-extinguishing system to de-energize replacement-air unit when fire-extinguishing system discharges.

E. Unit Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:
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- Filter dirty.
- Fan operating.
- Cooling operating.
- Heating operating.

F. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb <Insert value> of dry air or outdoor-air temperature is less than 60 deg F.
2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
3. Wall-mounting, relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 60 percent.

G. Heating Controls:

1. Factory-mounted sensor in supply-fan outlet with sensor adjustment located in control panel modulates gas furnace burner to maintain space temperature.
2. Remote Setback Thermostat: Adjustable room thermostat selected by timer, set at 50 F; cycles supply fan and gas furnace burner to maintain space temperature.
3. Staged Burner Control Four steps of control.
   OR

4. Electromechanical or Electronic Burner Control: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual furnace units.

H. Electric-Resistance Heating Controls: Wall-mounting thermostat controls SCR Damper Controls:

I. Space Pressure Control:

1. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop replacement-air unit at minimum 0.05-inch w.c.
2.13 INTEGRAL SMOKE ALARM: SMOKE DETECTOR INSTALLED IN SUPPLY AND RETURN AIR.

A. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC." Links shall include the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
   a. Room temperature.
   b. Discharge air temperature.
   c. Refrigeration system operating.
   d. Furnace operating.
   e. Constant and variable motor loads.
   f. Monitor variable frequency drive operation.
   g. Monitor cooling load.
   h. Monitor economizer cycles.
   i. Monitor air distribution static pressure and ventilation air volumes.

2.14 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

END OF SECTION 237433
CUSTOM FACTORY FABRICATED AIR HANDLING UNITS
SECTION 237500 - CUSTOM FACTORY FABRICATED AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Design, performance criteria, controls, and installation requirements for Custom Air Handling Units.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.3 COORDINATION

A. In addition to the coordination requirements specified elsewhere in the contract documents, it shall be the responsibility of this manufacturer and the mechanical contractor to confirm all dimensions and structural details based on the latest architectural and structural drawings relating to column, beam or wall locations or any other obstructions that must be accommodated as part of the equipment layout and support or to provide proper equipment clearances.

B. Any resulting costs due to failure to coordinate or comply with the contract document requirements shall be the sole responsibility of this contractor.

C. Coordinate installation of equipment supports, including locations for mechanical and electrical connections.

1.4 SUBMITTALS

A. Submit the following according to the Conditions of the Contract and as specified in Division 01 Section Submittals and Division 23.

B. Mechanical Contractor shall submit complete MER sheet metal and piping shop drawings to the air handling unit manufacturer prior to submission to the Engineer. The AHU manufacturer shall review the air performance and acoustical performance of the AHU as well as all
connections in the location and with the ductwork and piping configuration and construction as indicated on the shop drawing. AHU manufacturer shall note any comments relating to ductwork or piping layout and construction that would adversely affect the air and/or acoustical performance or the maintenance or accessibility of the AHU directly on the shop drawing.

C. Provide product data which shall indicate capacities, pressure drops, ratings, fan performance, coil performance data, furnished specialties, accessories, sound data, motor electrical characteristics, and gauges and finishes of materials.

D. Provide fan curves with specified operating point clearly plotted.

E. Provide coil selection data sheets, clearly showing input data with proper consideration for altitude, air density, as well as clearly indicating the selected coils output data.

F. Provide details showing condensate drain connection height and required P-trap height.

G. Submit product data of filter media, filter performance data, filter assembly, and filter frames.

H. Shop Drawings shall detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, shipping, method of field assembly, components, and location and size of each field connection. Details of connections for ductwork, steam, water, power, etc. and installation and startup instructions.

I. Submit details of thermal performance of casing panels, including, but not limited to, thermal break construction details, and performance calculations.

J. Dimensioned plan and elevation view drawings, including motor starter, VFD and control cabinets, required clearances, and location of all field connections.

K. Submit air handling unit inlet, discharge, and radiated sound power levels at nominal capacity.

L. Wiring Diagrams: Detail wiring for power supply. Detail laddertype wiring diagrams for interlock, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring.
M. Start-up Reports: Indicate results of start-up and testing requirements. Submit copies of checklists.

N. Operation and Maintenance Data: Submit maintenance data and parts list for each unit, including trouble shooting maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in the maintenance manuals as specified in Division 01.

1.5 VERIFICATION OF FACTORY RUN-IN TEST

A. Every unit shall be factory run-in tested.

B. The units and their components shall be factory tested according to the applicable portions of ARI and the components shall be listed and bear the label of the Air Conditioning and Refrigeration Institute (ARI).

C. Factory Testing:

1. The unit manufacturer shall either have within their factory or shall utilize some other testing facility to run these tests.

2. The units shall be tested by a Manufacturer’s Engineer with a copy of test reports submitted to the design engineer for review and acceptance prior to shipping the units.

3. Prior to the assembly of the unit, pressure test all coils (as specified under another section of this work).

4. Factory test shall include, but not limited to: dynamic trim balance of completed fan assembly; complete run check of all control and electrical components and safeties, including proper control sequencing; leak check of completed refrigerant circuit, unit leakage test and sound performance testing.

5. Factory tests shall be witnessed by Owners Representative, CM and Engineer. The final component and leak tests for all units shall be witnessed; the number of trips should not exceed three (3) visits to the factory and will be paid by the Owner. All
additional costs due to the failure of the air handling units or a delay in testing shall be borne by the Manufacturer.

6. Every unit shall be dynamically balanced and tested at the factory at design RPM to less than 3 mils peak-to-peak.

7. Unit Leakage:
   a. Unit manufacturer shall provide tests to verify CASING LEAKAGE. Casing leakage tests shall verify that unit casing leakage is less than 1% of design airflow at 1.5 times the design static pressure. Duct openings in positive pressure section shall be sealed. This section shall be connected to a fan developing 1.5 times design positive static pressure and CFM of this fan which shall be read using a calibrated orifice plate device. CFM shall be considered casing leakage. Duct openings in negative pressure section shall be sealed. This section shall be connected to a fan developing 1.25 times design negative static pressure and CFM of this fan which shall be read using a calibrated orifice plate device. CFM shall be considered casing leakage. This air leakage rate shall be achieved without the use of external caulk type sealer. This requirement assures the leakage rate does not increase as the unit ages.

8. Deflection:
   a. Unit casing deflection shall be limited to 1/240 of the span at the maximum fan static.

9. Sound Power Levels:
   a. Sound testing shall be conducted under controlled conditions at the factory. All test data shall be according to AMCA 300 and ANSI S12.31-1990 and S12.32-1990. Maximum sound power levels shall not exceed NC 35 within any interior space and meet all New York City Building Code sound levels.

10. As part of the factory test all factory piping shall be air pressure leak tested. The test pressure shall be as specified hereinafter. The factory pressure test of the refrigerant
circuits shall use nitrogen and shall be continuously maintained for a minimum of two (2) hours after which each piping joint, connection, etc., shall be examined to verify there is no evidence of weeping or leakage.

11. Compressor assembly shall be run tested at the factory. Vibrations shall not exceed 0.14 (inch per second) at the compressor housing.

12. The factory test instrumentation shall be per latest edition ARI Standards and the calibration of all instrumentation shall be traceable to the National Institute of Standards Technology (formerly NBS).

13. A certified test report of all data shall be submitted to the Owner prior to shipping. The factory certified test report shall be signed by an officer to the company from the manufacturer. Preprinted certification will not be acceptable; certification shall be in the original.

14. The equipment will be accepted if the test procedures and results are in conformance with ARI Standards. If the equipment fails to perform within allowable tolerances, the manufacturer will be allowed to make necessary revisions to his equipment and retest as required.

15. The air handling unit automated controls test shall be executed to check for proper wiring and ensure correct controls operation. Provide demonstration of BACnet interface of all air handling unit data.

16. Manufacturer to provide all current traceable certification for all calibration equipment prior to the commencement of testing,

D. Field Testing:

1. Once all the components have been assembled in the field, all components shall be tested to ensure they match the factory test data. The tests will include, but not limit to, pressure tests, functionally tests of all components, controls testing, etc. Manufacturer shall be present at the field testing of all air handling units.
1.6 DI-ELECTRIC FITTINGS

A. Provide dielectric fittings to isolate joined dissimilar materials to prevent galvanic action and stop corrosion. Fittings shall be of the non-reducing type, which shall be suitable for the system fluid, pressure and temperature and shall not restrict the flow. See section 2305 50 for additional requirements.

1.7 QUALITY ASSURANCE

A. Manufacturers Qualifications: Firms regularly engaged in the manufacture of custom, factory fabricated air handling units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Their quality control procedures must be thoroughly documented to ensure a consistently high quality product.

C. A manufacturer’s representative shall be available either directly from the factory or through the local certified factory representatives.

D. Codes and Standards:

1. All components (where applicable) of the units shall be listed by ETL or UL and have ETL or UL label.

2. Unit shall have an ETL or UL label as a unit.


5. Filter Media: ANSI/UL 900 listed, Class I, approved by local authorities.

6. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.

7. Provide electrically operated components specified in this Section that are ETL or UL and NEMA listed and labeled.
8. Comply with NFPA 70 for components and installation.


10. Air handling unit shall be designed and constructed to meet applicable UL requirements and shall bear the ETL or UL label. The entire air handling unit package shall be U.L. listed or ETL labeled.

E. Each compressor assembly shall undergo a mechanical run-in test to verify vibration levels and oil pressures and temperatures are within acceptable limits. Each compressor assembly shall be proof tested at a minimum of 232 psig (1600 kPa) and leak tested at 270 psig (276 kPa) with a tracer gas mixture. The leak tests shall not allow any leaks greater than 0.5 oz/year of refrigerant.

F. All electrical fitting connections shall be watertight.

1.8 DELIVERY, STORAGE, AND HANDLING

A. The air handling units shall be shipped to the riggers yard and remain there until the units are ready to be lifted into place at the site. The entire unit shall be one piece or of sectionalized (segmented) construction to allow for ingress to the construction site as dictated by the job site conditions. The individual sections shall be rigged into place on one common perimeter base.

B. Lifting lugs will be supplied on each side of each section to facilitate rigging and joining of sections.

C. Units with shipping sections shall be either bolted and gasketed for easy field assembly. Sealant, gaskets and associated hardware shall be provided for re-connection of unit modules. Units requiring field installation must be assembled under supervision by factory trained and employed personnel from the air unit manufacturer.

D. Handle package units and components carefully to prevent damage. Replace damaged package units or components with new.
E. Store package units and components off the ground and protect from physical damage.

F. Rig package units to comply with manufacturer's rigging and installation instructions for unloading package units, and moving them to final location.

G. Deliver units as factory-assembled units with protective crating and covering, all air handling units shall be internally cleaned and all openings shall be sealed.

H. Coordinate delivery of units with CM.

I. Mount a permanent nameplate on the unit to display the manufacturer, serial number, model number, date of manufacture, horsepower, current and voltage.

1.9 SCHEDULING AND SEQUENCING

A. Coordinate installation with the existing roof structure.

B. Coordinate opening locations for mechanical and electrical connections. Refer to the attached drawings for the existing curb sizes, openings, etc.

1.10 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer, agreeing to replace parts or components that fail in materials or workmanship, within the warranty-period, provided manufacturers written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period: 2 years after date of Substantial Completion on all components.

2. Extended warranty period for compressors: 5 years after date of Substantial Completion.
3. Extended warranty period of 15 years against corrosion of casing, walls, floor and roof panels.

4. Provide 1 year maintenance contract with four (4) renewable 1 year options.

5. Warranty shall commence when beneficial to the facility as documented by the Owner and CM.

1.11 EXTRA MATERIALS

A. Furnish to Owner, with receipt, the following spare parts for each air handling unit:

1. One set of matched fan belts for each belt-driven fan.

2. Two (2) sets of spare filters for each filter bank for each unit.

3. Provide one (1) fan cube for each fan cube size.

1.12 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation and commissioned by the Owner’s Commissioning Agent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The following vendors will be reviewed for approval providing they meet all of the performance requirements of the specifications.

1. Mammoth

2. Energy Labs Inc.

3. Air Enterprises.

4. Governair
5. Hakkon

6. LSB Industries

### 2.2 GENERAL DESCRIPTION

**A.** Units shall be of the exterior type with heavy duty high pressure double wall construction, with integral thermal break system, suitable for the scheduled duty requirements. All internal components specified in the air handling unit schedule or specified herein shall be factory furnished and installed. Unit(s) shall be completely factory assembled. Air handling unit will utilize refrigerant R-410A, air handling units using refrigerants such as HCFC-22, CFC-11, 12, 500 shall not be acceptable.

**B.** Units shall be arranged to have the following components, return fan, pre-filter and cartridge filter, supply fan (fan array), DX evaporator coil, gas fired heater, humidifier, final filter, backdraft dampers, access panels, discharge plenum, condensing unit with compressors mounted next to the air handling unit.

**C.** Units shall be provided with factory installed DX coil, humidifier, steam and coil piping. For coil piping details, see details on drawings and specifications. The factory installed piping shall exit the unit as indicated on the drawings. The automatic control valves and dampers with the exception of the refrigerant system control valves shall be furnished by the BMS contractor for installation by the Mechanical Contractor.

1. The steam piping shall be Schedule 40, seamless or ERW. The fitting shall be malleable iron 150 lbs., cast iron 125 lbs., screwed or socket weld for piping less than 2-1/2” and Schedule 40 weld end for piping 3” and above. The steam condensate piping shall be Schedule 80, seamless, the fittings shall be iron 150 lbs., screwed or socket welded. The refrigerant piping shall be installed per the manufacturers recommendations. The humidifier piping shall be copper type L, hard drawn. The fittings shall be wrought or copper brazed.

2. The internal piping shall be sized to limit the overall pressure drop of the coil (including the internal piping) to that scheduled on the drawings. All internal cooling coil, steam and condensate piping shall be insulated.
3. The refrigerant piping insulation shall be 1-½” thick fiberglass with a maximum K factor of 0.24 at 75 degrees F mean temperature with factory applied all service jacket. Insulation shall be rigid, molded, one-piece, fiberglass insulation that is bounded with thermosetting resin, similar to Schuller Micro-Lok with AP-T Plus Jacket. The longitudinal lap of the all-purpose jacket shall be sealed using manufacturer supplied butt strips. All fittings, valves, flanges and pipe terminations shall be fully insulated with glass fiber insulation and molded fitting covers. Thickness of insulation shall be as great as that on the adjoining pipe and shall be vapor sealed. Flange insulation shall extend a minimum of 1” beyond the end of the bolts, and the bolt area shall be fitted with Mineral Wool Cement.

4. The low pressure steam and steam condensate return shall be 1-½” thick for piping up to 1-½” diameter and 3” thick for piping size 2” to 6”. Insulation shall be fiberglass with maximum K factor of 0.24 at 75 degrees F mean temperature and shall be furnished with a factory supplied all-service jacket. Insulation shall be capable of continuous service at a pipe temperature of 452 degrees F without oxidation, burnout of binders, or development of odors or smoke. Insulation shall be rigid, molded, one-piece, fiberglass insulation that is bounded with thermosetting resin, similar to Schuller Micro-Lok with AP-T Plus Jacket. The longitudinal lap of the all-purpose jacket shall be sealed using manufacturer supplied butt strips. All fittings, valves, flanges and pipe terminations shall be fully insulated with glass fiber insulation and molded fitting covers. Thickness of insulation shall be as great as that on the adjoining pipe and shall be vapor sealed. Flange insulation shall extend a minimum of 1” beyond the end of the bolts, and the bolt area shall be fitted with Mineral Wool Cement.’

5. Piping shall be terminated with a flanged connection and an air seal device.

6. Internal piping shall be internally braced to prevent any movement during shipping or field assembly.

7. Units shall be manufactured of double wall construction containing insulation for the entire unit, consisting of walls, roof, and base; insulation must comply with NYC Code. The panel R value shall be a minimum of R13 or greater. The entire walls and roof shall be constructed of panels that are individually removable and of gasketed
thermal break construction. The outer and inner walls shall be 16 gauge, galvanized steel painted with a baked on polyester-ceramic paint system that shall pass 1000 hour ASTM B-117 salt spray resistance and 3000 hour ASTM G-23 accelerated weathering with integral thermal break gasketed construction. Caulking of panels will not constitute thermal break construction. All interior wall panels shall be 20 gauge, 304 stainless steel. The floor panels shall be 10 gauge aluminum thread plate.

D. Unit shall be constructed to maintain casing design loading deflection criteria of 1/240 at 30#/sq. inch with a 4" negative and 6" positive static pressure without sagging, pulsating or oil canning.

E. Perimeter base air handling unit manufacturer shall provide a welded steel base to elevate the unit off the floor for housekeeping as well as to allow for piping of condensate drain lines and traps. Rail shall be manufactured of 16# structural steel sized to provide adequate permanent support below the entire air handler perimeter base and shipping splits to support internal components without sagging, pulsating, or oil-canning. Base shall ship broken down in pieces with all mounting hardware for field assembly by the contractor as dictated by the job site conditions. Base height shall be a minimum of 6” or as noted on the drawings.

F. The perimeter base frame shall have electrically welded integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located and sized to allow rigging and handling of the unit. After fabrication and welding, the base frame shall be coated with an air-dried enamel.

G. Floor Construction, Double Wall: Floors shall be bolted and gasketed double wall and insulated. Floor sheets shall be fabricated of 10 gauge aluminum thread plate with 16 gauge painted galvanized outer skin. Insulation to be provided with thermal break gasketed construction. Floor construction in active wet areas such as a cooling coil and humidifier sections shall be 20 gauge, 304 stainless steel. Floor shall have 2" turned up lip around the full perimeter of the unit. The floor shall be suitably braced to prevent oil canning. The unit base floor shall be designed to support a minimum live load of 100#/SF throughout the unit. Floors shall be designed to deflect no more than 1/200 of span under operating conditions. Formed intermediate cross flooring members shall be constructed of commercial quality hot rolled 10 gauge sheet steel. All seams in the floor surface shall be continuously
welded. All opening in the floor shall be framed by a collar which extends 2” above wearing surface. Floor sheets shall be welded to all perimeter and intermediate base frame members. Insulation on top of the floor or on the floor surface is unacceptable.

H. Roof construction: The outdoor air handling unit shall have 16 gauge galvanized solid steel outer panels with 20 gauge stainless steel inner panels and shall be designed to support a minimum live load of 100 #/SF, to allow safe access to the top of the unit. All exterior joints shall be bolted and gasketed and continuously sealed. Roof shall be pitched to prevent water from collecting.

I. Removable access panel shall be provided as indicated on the drawings and/or as required for complete service and maintenance (including removal) of each unit component. Access panels shall be of the same construction as panels described above. Removable access panels shall be designed and constructed such that removal and replacement may be accomplished without disturbing adjacent panels and without affecting the structural integrity of the unit. Airtight integrity must be maintained.

J. Unit Access Doors:

1. Access doors shall be provided into all sections of the air-handling unit. Doors shall be man-sized and a minimum of 3" deep with R12.5 insulation and shall be double wall with both sides constructed with the same material as the outer skin of the unit. All doors shall have continuous 14 gauge stainless steel piano hinges. The door and the door panel shall incorporate a thermal break into its construction to prevent sweating. The door shall have double EPDM sponge rubber bulb type gaskets.

2. The doorframe shall have an outer layer of stainless steel welded in the corners to provide an air tight seal and an inner metal liner. The doorframe shall incorporate a thermal break gasket. The frame parts shall be securely fastened by solid rivets. Pop rivets are not acceptable. Doors shall have a minimum of two locks handles each. Door latch shall consist of an inner and outer handle of cast red brass, connected together with a stainless steel rod. A cast red brass latch plate shall be fastened to each side of the door through a 1/8" thick gasket and serve as a bearing plate for the stainless steel rod. Aluminum rods riding on raw sheet metal edges are
not acceptable. The outer handle shall have an integral high compression arm to provide the closing pressure on the gasket. Die-cast zinc aluminum latch handles are not acceptable due to their tendency to "creep" under pressure after extended periods.

3. Access doors to be installed such that pressure doors open inward and negative pressure doors open outward. Doors shall swing freely 180° and shall under no circumstances open outward when exposed to positive pressure. Each door shall be provided exposed to positive pressure. All outward swinging doors shall have door tie backs and door stops.

K. Each section of the unit base shall contain a minimum 1" NPT drain to facilitate system washdown and condensate removal. Areas in the base where potential standing water cannot be removed through drains or weep holes are not acceptable. Drains shall be provided with removable caps of non-corrosive material.

L. To minimum thermal conductivity and prevent condensation, the entire perimeter frame shall be uniformly insulated.

M. Casing shall comply with NFPA 90A requirements.

N. The average thermal conductance of the unit casing shall not exceed 0.06 BTU/SQ.FT./HR/°F. Manufacturer to provide documentation to ensure the air handling units are in compliance with the thermal conductance analysis.

O. Entire casing system as well as each component (panels, walls, roof, floor, access doors, etc.) shall be guaranteed that the acoustical, thermal, cleanliness, structure, etc. performance, as specified herein, are not compromised.

P. All ferrous parts shall have a full G-90 ounces per square foot of commercial grade galvanizing or have equivalent corrosion resistance when in an unpainted condition. Galvanizing shall be done before construction - all component parts of frame internal and external shall be galvanized.

Q. Painting and surface preparation shall be done prior to assembly. Interior and exterior surfaces shall have two (2) coats of an epoxy corrosion resistant primer.
R. Exterior Finish:

1. The galvanized exterior shall be treated and painted as follows:
   a. All surfaces will be wiped with cleaning solution to remove oils and markings.
   b. All welded areas of galvanized steel shall be touched up with corrosion resistant paint.
   c. All exterior surfaces shall be spray painted with one (1) coat of 1 millimeter of sandstone bake polyester coating.

2. When tested in accordance with ASTM B-117 the finished unit shall withstand 125 hour salt spray solution (5%) without any sign of red rust.

2.3 FANS (PLENUM FANS) (RETURN FANS)

A. General: Plenum Fans shall be of the belt driven centrifugal type as specified. Fan shall be constructed of heavy gauge steel with bearing support members positioned to directly oppose belt tension. Mounting panel shall have formed flange with welded corners on all four sides to insure flatness and rigidity and shall have pre-punched mounting holes for vertical or horizontal installation. The plenum fans shall be enclosed in an OSHA safety screened protection cage.

B. Fan shall include mounting panel, wheel, fan shaft, bearings and welded structural support members as a factory assembled unit. All steel and sheet metal parts shall be thoroughly cleaned, conditioned, and painted with enamel primer and enamel top coat prior to final assembly. A final coat of enamel shall be applied to all exterior surfaces after assembly.

C. Plenum fans shall be of the non-overloading steel backward inclined wheel type, as specified. Blades on all sizes and classes shall be securely welded to both a deep spun inlet shroud and a heavy backplate.

D. Fans to be non-overloading having a sharply rising pressure characteristic which will extend throughout the operating range and continue to rise well beyond the efficiency peak to insure
quiet, stable operation under all conditions. The horsepower characteristic shall be truly self-limiting and shall reach a peak in the normal selection area.

E. Fan shaft to be properly sized and protectively coated with lubricating oil. Fan shafts shall be solid steel shaft and properly designed so than fan shaft does not pass through first critical speed as unit comes up to rated RPM. Fan wheels to be secured with slotted keyways on solid shafts and with taper lock hubs on tubular steel shafts to prevent slipping. Rust preventive coating to be provided.

F. Fans shall be statically and dynamically tested and balanced, in the factory, as an assembly at the required RPM to meet the design specifications. Key fan wheels to fan shaft to prevent slipping.

G. After the pre-balanced fan is installed in the air handler, the entire fan section shall be run-balanced at the speed to insure smooth and trouble-free operation. Fans shall be provided with variable frequency drives and shall be balanced for inverter duty operation. The fan shall be balanced over the entire range of fan operation (30% to 100% of RPM). Filter-in measurements shall not exceed 5 mils in the horizontal and vertical planes. Filter-out measurements shall not exceed 7.5 mils in the horizontal, vertical and axial planes.

H. The fan shall have heavy gauge spun aluminum inlet cone carefully matched to the e wheel shroud to provide smooth airflow and quiet, efficient operation.

I. Provide a velocity pressure converter cone at the discharge of the fan. The cone shall be constructed of # 20 gauge galvanized sheet steel with 2 inch diameter holes on 15/16 inch staggered centers. Configuration shall be of the pyramid or cone trussrom design reinforced and shall have a free area of not less than 150% of the fan discharge area.

J. Bearings - Self-aligning, heavy duty, grease lubricated, ball type. Internal bearings, where used, shall be provided with extended fittings mounted externally at drive side of unit. Minimum 200,000 hours average L-10 life, as defined by AFBMA.

K. Drive - Fixed, minimum of two grooves furnished on all motor sizes. Drive sized for 1.5 x motor H.P. Belt guard to meet OSHA requirements and to have access opening for RPM readings. Provide belt guard (whether motor is inside or outside unit).
L. Fan and fan motor shall be internally mounted and isolated on a full width isolator support bases as specified. The motor and fan base shall be welded or bolted to form a common base to prevent any uncommon physical motion of the fan and motor.

M. Install flexible canvas ducts between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A.

N. Inlet Screens: Required for all fans, constructed for easy removal, of heavy wire mesh.

O. Drain Connections: A 1” drain to be provided at bottom.

P. The fan and motor shall be mounted on stable free standing spring isolators with 3” maximum deflection rating. Spring efficiency to be not less than 98%.

Q. Fan shall be provided with a mechanical brake, coordinated with BMS.

2.4 FAN ARRAY (SUPPLY FANS)

A. The fan array system shall consist of multiple, direct driven, arrangement plenum fans constructed per AMCA requirements for the duty specified, (Class I, II, or III). All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system total static pressure that does not exceed 90% of the specified fan’s peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11-gauge, A60 Galvanized steel intake wall, 14-gauge spun steel inlet funnel, and an 11-gauge G90 Galvanized steel motor support plate and structure. All motors shall be standard pedestal mounted type, TEFC, T-frame motors selected at the specified operating voltage, 1750 RPM, and efficiency as specified or as scheduled elsewhere. All motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

B. The fan array shall consist of multiple fan and motor "cubes," spaced in the airway tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. Multiple fan cubes shall be wired to a VFD.
as specified elsewhere for each fan motor, driven by a "master/slave" control scheme. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.

C. The fan array produces a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the Fan Wall array intake plenum wall, and at a distance of 48" from the discharge side of the fan array intake plenum wall.

D. Each fan/motor assembly shall be removable through a 36" wide, free area, access door located on the upstream side of the fan array.

E. Alternate fan array schemes will be reviewed as an approved equal.

F. Manufacturer to provide an add alternate price to provide a fan array for the return fan and all associated accessories, including but not limited to VFD’s, dampers, etc.

2.5 ELECTRIC MOTORS

A. See detailed specifications under another section of this work. Scheduled brake horsepower shall not be exceeded. All motors shall be high efficiency. The fan motor shall be factory pre-wired.

B. The motor shall be mounted on the same isolation base as the fan. The motor shall be on a slide base to permit adjustment of belt tension. The fan and motor drive vibration isolation base shall be mounted on seismic type spring isolators selected for 2" deflection and sized for 95% isolation efficiency.

C. The air handling unit manufacturer shall pre-wire the casing sections as required and provide code approved wiring termination enclosures to permit easy disassembly and field reassembly of the various air handling unit casing sections fan motors, internal lights and switches, 120 volt GFI power receptacles, etc. for a complete factory pre-wired air handling unit assembly. Reconnection of wires at junction box are the responsibility of the installing subcontractor. Unit wiring shall terminal in a NEMA 1 enclosure terminal panel with a tagged terminal strips.
D. Fan unloading for variable-air-volume control shall be accomplished through a variable frequency drive, as specified under another Section.

E. After final assembly, the fan and motor assembly shall be factory balanced for 10 - 100% of design speed of the air handling unit. Units that are balanced for a specific point of operation shall be field balanced for the entire RPM range.

F. After the air handling unit is installed, the unit VFC shall be field commissioned by a factory trained and employed service technician.

2.6 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Units shall operate on voltage/phase, 60 hz. as scheduled on the documents. Unit shall be guaranteed to operate continuously at that voltage plus or minus 10% without injurious overheating.

B. Vapor Proof Service Lights: Each section shall be equipped with a marine type vapor proof service light. Some units shall require two (2) service lights per unit section and in the vestibule. All lights and external switches (located near each access door) shall be completely installed and wired to the unit control panel. Lights shall be wired so they are functional whether the main power disconnect is in the on or off position.

C. The air handling unit manufacturer shall pre-wire a 120 volt ground fault circuit interrupting convenience receptacle inside each casing section and on the exterior of the air handling unit, one (1) duplex outlet near each end of the unit.

D. The air handling unit manufacturer to provide a means to route electrical power through the air handling unit.

2.7 FILTERS

A. All filters shall be furnished to meet the performance requirements set forth in the schedule and as specified under another section of this work. All coils shall have performance certified in accordance with ASHRAE and shall be UL Rated.
B. The filter frames shall be constructed of galvanized steel and be built as an integral part of the unit. All filter segments shall be serviceable with access doors.

C. A manometer, differential pressure gage shall be factory installed and flush mounted on drive side to measure the pressure drop across the filters.

2.8 APPURTENANCES

A. No water carry-over from cooling coils into air stream accepted. Eliminators shall be provided where required by unit manufacturer. Pressure drop across eliminator shall be maximum 0.15" W.G. at 500 FPM, coil face velocity.

2.9 DRAIN PAN

A. Cooling coils, and humidifier sections shall have full length drain pans. The drain pans shall be 16 gauge 316 stainless steel and insulated with 2" - 2.77# insulation. The pan shall be sloped a minimum of 1" in direction of air flow and 2" in the width of the unit to minimize standing water.

B. Drain pans shall start 2" upstream of coil and extend beyond the coil by a distance which is at least 1/3 the height of the bottom coil for the length of the section. Total drain pan height shall be 6". All drain piping from the pans shall be trapped.

C. Intermediate drain pans for stacked coils shall have drains on both sides piped with 1 ¼” copper tubing to the main pan. Intermediate drain pan shall be constructed with same material as main pan described in paragraph A of this section.

2.10 COMPRESSORS

A. The compressor shall utilize an orbiting scroll with axial and radial compliance and have electronic temperature controlled gas bypass capacity modulation technology. The compressor shall be capable of seamlessly modulating capacity from 10% to 100. The compressor shall be a high efficiency, suction gas cooled, hermetic type, with Teflon bearings and a cast iron motor frame. The compressor shall be mounted outside of the air stream on rubber-in-shear isolators. The compressor shall have an oil level sight glass, oil level adjustment fitting, high and low pressure taps, and full port discharge and suction
service valves. The compressor shall have a check valve in the discharge fitting to control discharge gas flow and to silently prevent reverse rotation. The compressor shall have four motor winding temp sensors with a solid state module for compressor overload protection. Other safety devices shall include a crankcase heater, high pressure and low pressure freeze protection.

B. Supply multiples on compressors as indicated on the schedule.

C. Compressor service valves to be back seating type with seal caps to protect the stem and stem packing. Oil charging valves to be positive closing type located in compressor crankcase. All refrigerant piping shall be supported by grommeted strap hangers. There shall be an adjustable ambient compressor lockout control.

D. All necessary piping, triple evacuation and charging shall be by the unit manufacturer and shall include complete shop testing with reports filed prior to shipment.

E. Each independent refrigerant circuit shall be completely piped, tested, dehydrated and fully charged with oil and refrigerant R410A. Each refrigerant circuit includes compressor, condenser with integral sub-cooler, liquid service line and charging valve, filter dryer, removable core with valved bypass, slight glass, fusible plug and thermostatic expansion valve.

2.11 INTEGRAL AIR COOLED CONDENSER SECTION

A. Shall be sized at a maximum 95°F ambient design. The Condenser Section shall utilize multiple propeller direct driven condenser fans of the size and capacity as required; and be arranged for vertical air discharge. Condenser coils shall utilize not less than 1/2" copper tubing with continuous aluminum plate fins for extended heat transfer surface. Fins shall be spaced not more than ten (10) per inch. Coils shall be constructed in such a manner as to utilize the fewest brazed joints possible. Coils shall be of the design having full air entrance. Coils shall have ARI Ratings. Coils shall be minimum (3) three rows deep and shall be sized to handle 1000 CFM/ton at maximum 600 fpm. Coils shall have a 15E integral sub-cooled circuit.
B. Condenser fans shall be of a heavy duty construction utilizing one piece composite blades with steel hub securely fastened to a solid steel shaft. Fans shall not exceed 48” in diameter and shall be maximum 1140 RPM. There shall be discharge and inlet protection screens.

C. Fans shall be set in a deep venture ring. Fans shall have the ability to deliver against 1/8” external static pressure and still deliver air capacity sufficient to maintain rated unit heat rejection. All bearings shall have extended lubrication lines. Shafts shall be epoxy coated steel. Provide ambient control to 40E by fan staging-adjustable head pressure controller - Hoffman control system with individual circuit sensing probes.

D. Each refrigerant circuit shall contain, but not be limited to the following:

1. Compressor with service valves, charging ports, liquid line filter dryer with replaceable cores with 3-way valve bypass, sight glass, solenoid valve, thermal expansion valve, hot gas bypass, and gauge ports for high, low and oil pressure, and receivers. Insulate all suction lines with ½” Armaflex.

2. Condenser fans shall be three-phase integral horsepower type NEMA construction, for outdoor installation.

3. Motors shall have an integral rain shield, permanently lubricated bail bearings and not less than a NEMA Class B insulation system. Fractional horsepower, single phase or NEMA Class A insulation rated motors will not be accepted.

4. Inlet and discharge sound attenuating hoods and plenums shall be field mounted by the HVAC contractor. These hoods shall fit the condenser coils, and entire propeller sections; they shall be sound tested at the unit manufacturers test lab.

2.12 HUMIDIFIERS

A. Manufacturers:

1. Dristeem

2. Armstrong
B. Humidifier shall receive steam at supply pressure and discharge at atmospheric pressure.

C. Separating chamber shall be of a volume and design that will disengage and remove all water droplets and all particulate matter larger than 3 microns when humidifier is operating at maximum capacity. A stainless steel filtering medium shall be included, to remove particulate matter in the chamber.

D. The metering valve shall be steam heated and shall have a plug, capable of modulating flow of steam to provide full control over the entire stroke of the operator. Hysteresis of the valve shall be less than ½ psig over 100% of valve travel.

E. The internal drying chamber shall receive steam at essentially atmospheric pressure and be jacketed by steam at supply pressure. Asbestos shall not be used anywhere in the humidifier.

F. The silencing chamber shall be steam jacketed and utilize a stainless steel silencing medium.

G. The distribution manifold or manifolds shall provide uniform distribution over its entire length and be jacketed by steam at supply pressure to assure that vapor discharged is free of water droplets. A full length stainless steel internal silencing screen shall be provided if required for sound control.

H. Humidifier shall be equipped with an interlocked temperature switch to prevent the humidifier from operating before start-up condensate is drained.

I. Humidistats will control electric control valve.

J. Provide steam piping, two gate valves, strainer, check valve, and inverted bucket steam trap for each humidifier. Steam piping shall be insulated.

K. Spill condensate from humidifier to drain pans in unit where applicable. Drain pan shall be stainless steel.

L. Where more than two manifolds are required, the piping shall be as follows. The manifolds shall be jacketed and trapped separately from the humidifier. The humidifier shall receive steam directly from the steam supply line. The trap for the manifolds shall be an F & T trap. The trap for the humidifier shall be an inverted bucket type.
M. Number of manifold and control valves as required by humidifier manufacturer for various duct or air handing units.

N. Entire assembly shall be supplied, mounted, piped, and control wired by the unit manufacturer.

2.13 STEAM TO STEAM HEAT EXCHANGER

A. Manufacturers:
   1. Dristeem
   2. Armstrong

B. Steam to steam heat exchanger shall generate steam from tap water by passing existing plant steam through a heat exchanger submerged in water. Heat exchanger will be constructed of either electroless nickel plated copper, or stainless steel, and will be properly sized to produce amount of steam required based on inlet steam supply pressure.

C. Steam to steam heat exchanger shall utilize disposable ionic bed inserts for tap water service to attract solids from boiling water. Ionic beds ensure controllability through responsive and consistent humidity output regardless of water quality and minimize downtime required for tank cleaning.

D. Steam to steam heat exchanger shall monitor tank operating history, and display will indicate when unit needs ionic bed replacement. Service life cycle may be field-adapted to match water quality.

E. Steam to steam heat exchanger shall have modulating control to provide 0% to 100% of maximum capacity. Humidifier is field-adaptable to 0-10 Vdc, 1.9-3.9 Vdc, 4-20 milliamp, 0-135 ohms, or an on/off input signal.

F. Tank drain shall be cycle based on operating history in order to conserve water and energy.

G. Steam to steam heat exchanger shall incorporate stainless steel conductance-actuated probes with Teflon insulation for liquid level control on tap water service.
H. Steam to steam heat exchanger shall include lights indicating the unit has power on, is in the process of steam generation, and has a diagnostic error or that ionic beds are at the end of their service life.

I. Steam to steam heat exchanger shall incorporate electrical terminals for installation of controlling stat, duct high-limit stat, fan interlock switch and Class 2 alarm device.

J. The steam to steam heat exchanger shall connect to a humidified and shall be supplied with stainless steel steam dispersion tube(s) which provide uniform steam distribution over the entire tube length and shall be supplied at various lengths (through 10’) to adequately span the widest dimension of the duct.

K. Steam to steam tank shall be constructed of stainless steel.

L. The steam to steam heat exchanger shall not be located within the air stream, and will be mounted external to the air handling unit in a weatherproof outdoor enclosure that is part of the air handling unit construction.

2.14 DAMPERS

A. The return, outside air, relief and isolation dampers shall be constructed of extruded aluminum including the frame, blades, and shaft as specified. Dampers shall be of the louver type with neoprene or vinyl edged blades and end seals and aluminum construction. All damper actuators shall be of neoprene or rubber diaphragm type.

2.15 Back draft dampers shall be constructed of extruded aluminum including the frame, blades and shaft as specified. The blades shall be contoured for strength and overlap edges with gaskets to ensure low leakage. The seals shall be extruded interlocked silicone rubber seals on blade edges and expanded polyurethane on frame.

2.16 MONORAIL SYSTEM

A. As part of each unit, provide a factory installed monorail system within each fan section over 15 HP for the rigging and removal of fans and motors.
B. Monorail system shall be sized by unit manufacturer to handle maximum weight of piece of equipment (motor, etc.) with safety factor to meet all applicable codes.

C. Coordinate monorail location with access doors to permit removal of equipment.

2.17 ROOF CURBS

A. Units shall be mounted existing roof curbs, the existing curbs will be modified to accommodate the new air handling units.

2.18 VESTIBULE

A. Outdoor air handling units shall be provided with a full height, internal, walk-in service vestibule to service the electrical and control components for both the air handling unit and condenser unit.

B. The vestibule shall be of double wall thermal break construction. The unit exterior shall be the same as specified herein for the air handling unit. The unit interior shall be 16 gauge painted galvanized steel.

C. The base floor construction shall be the same as specified herein for the air handling unit. In addition, the floor shall have 3/16” diamond tread plate. The entire base shall be thermal break construction.

D. The vestibule shall contain marine lights with a common switch and receptacle, access doors to the unit interior and vestibule exterior, and shall be of sufficient area to meet the National Electrical Code for the mounting of electrical components. All piping and electrical services shall penetrate the vestibule floor through factory sleeved pipe chases constructed of structural steel. The number of chases shall be as shown on the drawings and/or as required. The vestibule shall be ventilated and conditioned with a portion of the unit return exhaust air being discharged into the vestibule. The vestibule shall contain both a supply (return/exhaust) air and discharge exhaust automatic damper. In the case of 100% outside air systems a portion of the supply air shall be supplied into the vestibule. The vestibule shall also be provided with factory installed and wired electric unit heaters. The vestibule temperature
control system (damper operation, unit heater operation, etc.) will be provided by unit manufacturer.

E. The roof construction shall be the same as specified herein for the air handling unit. The roof shall be pitched to prevent water from collecting.

2.19 ULTRA-VIOLET (UV) LIGHT SECTION

A. General Requirements for UV-Light Sections:

1. UV-C light fixtures and lamps shall be provided by the air handler manufacturer. The UV-C fixtures shall be factory-assembled and tested in the air handler. Field-installed fixtures shall not be allowed.

2. UV Fixtures to meet UL Standards 153, 1598 & 1995

3. The UV-C fixtures and lamps shall be coupled end-to-end and mounted on a slide-out rack to enable complete replacement and/or maintenance of the bulbs from the unit exterior.

4. Voltage for lamps / transformers: 120V.

5. MC to provide unit mounted control panel housing: fuses, contactors, relays and wiring.

B. Protection of Polymeric Materials

1. All polymeric materials that come into direct or indirect (reflected) contact with UV-C light shall be tested and certified as UV-C tolerant. Any polymeric material in direct or indirect contact with UV-C light not certified as UV-C tolerant shall be completely shielded from the UV-C light using a certified UV-C tolerant material such as metal. UV-C tolerance is defined as being capable of performing its intended duty for a minimum of 20 years.

C. Safety
1. Access doors shall be provided at the location of each UV-C light as indicated on the plans and schedule. All sections of the air handler with access doors where the UV-C lights may pose a risk for direct exposure shall have a mechanical interlock switch that disconnects power to the lights when the door is opened.

2. In addition to the mechanical interlock switch, each unit shall be equipped with an externally mounted on-off/disconnect/shut off switch that disconnects power to the UV-C lights. The switch shall be equipped with a lock-out/tag-out to prevent unwanted operation of the UVC lights.

3. A view port with cover shall be provided in each UV section to allow viewing of the UV-C light array confirming operation. The view port and other AHU windows shall be treated to assure the UV-C energy emitted through it is below the threshold limits specified by NIOSH and ACGIH.

4. Units shall have a safety warning label applied to the exterior of each section containing UVC lights.

5. Complete safety, maintenance and servicing instructions for the UV-C lights and fixtures shall be incorporated into the air handler manufacturer’s standard installation, operating and maintenance manuals.

D.

2.20 CONTROLS

A. All D.D.C. electronic controls devices shall be furnished and installed by the manufacturer for all components of the air handling unit included but not limited to cooling, heating, humidification, and economy cycle controls. A remote keypad display terminal shall be provided for the owner’s use and readout of all unit functions. Provide auxiliary contacts for remote start/stop, status, alarm and reset monitoring capability from the BMS. The air handling units shall have a complete factory furnished, installed and wired control system with BACnet open protocol for BMS interface.
SELF-CONTAINED AIR-CONDITIONERS
SECTION 238119 - SELF-CONTAINED AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes packaged air-conditioning units with refrigerant compressors and controls, intended for indoor installations, with water externally mounted air integral air-cooled condensers.

1.2 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
D. Units shall be designed to operate with HCFC-free refrigerants.

1.3 FACILITY OPERATIONS REQUIREMENTS
A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.
B. Shop Drawings: Diagram power, signal, and control wiri
C. Factory quality-control and test reports.
D. Operation and Maintenance Data: For self-contained air-conditioners to include in emergency, operation, and maintenance manuals.
E. Warranty: Special warranty specified in this Section.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Self-Contained Air-Conditioners (Larger than 15 Tons):
   a. Task
   b. Carrier Air Conditioning; Div. of Carrier Corporation.
   c. York Corp.

2. Water-Cooled, Self-Contained Air-Conditioners 15 Tons and Smaller:
   a. Carrier Air Conditioning; Div. of Carrier Corp.
   b. Florida Heat Pump
   c. York Corp.

3. Remote Air-Cooled, Self-Contained Air-Conditioners 15 Tons and Smaller:
   a. Carrier Air Conditioning; Div. of Carrier Corp.
   b. Cool Air
   c. York Corp.

4. Integral Air-Cooled, Self-Contained Air-Conditioners 15 Tons and Smaller:
   a. Carrier Air Conditioning; Div. of Carrier Corporation.
   b. Cool Air
   c. Task
   d. York Corp.
   e. McQuay

5. Integral Air-Cooled, Wall-Mount Self-Contained Air-Conditioners 15 Tons and Smaller:
   b. Stulz Air Technology Systems, Inc.
   c. McQuay
2.2 PACKAGED UNITS

A. Description: Self-contained, factory-assembled and -wired unit; consisting of cabinet, compressor, evaporator fan, evaporator coil, air filters, and controls; and fully charged with refrigerant and oil.


B. Disconnect Switch: Factory mounted in control panel on equipment.

2.3 CABINET

A. Frame and Panels: Structural-steel frame with galvanized-steel panels with baked-enamel finish in color selected by Architect, and with access doors or panels.

B. Insulation: Minimum 1-inch- thick, acoustic duct liner on cabinet interior and control panel.

C. Drain Pan: Galvanized steel with corrosion-resistant coating Stainless steel.

D. Isolation: Spring isolators for mounting under base of unit, with minimum static deflection of 1 inch.

E. Discharge Plenum: Cabinet extension with duct openings for air discharge and lined with a minimum of 2-inch- thick duct liner.

F. Corrosion-Resistant Treatment: Phenolic coating on unit interior and exterior.

2.4 EVAPORATOR FAN

A. Material: Galvanized steel.

B. Configuration: Double-width, double-inlet, forward-curved or airfoil centrifugal fan; statically and dynamically balanced.

C. Drive: Belt, with fan mounted on permanently lubricated bearings.

D. Fan Sheaves: Cast-iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed.
E. Motor Sheave: Variable and adjustable pitch selected so required rpm are obtained when set at mid position.

F. Rating: As recommended by the manufacturer or a minimum of one and one-half times nameplate rating of motor.

G. Bearings: Grease lubricated with grease lines extended to exterior of unit.

H. Variable Air Volume: Variable-frequency motor controller.

I. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

J. Motors: Multispeed, PSC type.

K. Motors: Totally enclosed fan-cooled type.

1. Special Motor Features: Premium efficiency, as defined in Division 23 Section "Common Motor Requirements for HVAC Equipment."

L. Isolation: Mount fan and motor on common subbase and mount assembly on spring isolators with minimum static deflection of 1 inch.

2.5 COMPRESSOR

A. Description: Hermetically sealed, 3600 rpm maximum, and resiliently mounted with positive lubrication and internal motor protection.

B. Compressor Type Scroll.

2.6 EVAPORATOR COIL

A. Direct-Expansion Coil: Seamless copper tubes expanded into aluminum fins.


B. Refrigerant Circuits: A separate circuit for each compressor, with externally equalized thermal-expansion valve with adjustable superheat, filter-dryer, sight glass, high-pressure relief valve, and charging valves.
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

2.7 WATER-COOLED CONDENSER

A. Description: Copper tubes in steel shell with removable heads, for 400-psig waterside working pressure.
   2. Water-Flow Switch: Indicates flow.

2.8 REMOTE AIR-COOLED CONDENSER

A. Description: Factory assembled and tested; consisting of condenser coil, fans and motors, and operating controls; suitable for roof mounting.
   1. Condenser Coil: Aluminum-fin copper tube with integral subcooler; leak tested to 450 psig.
   2. Condenser Fans: Direct-drive propeller type.
   3. Fan Motors: Three-phase, permanently lubricated, ball-bearing motors with built-in thermal-overload protection. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   4. Refrigerant Line Kits: Annealed-copper suction and liquid lines that are factory cleaned, dried, pressurized, and sealed; insulated suction line; flared fittings at evaporator end, no fitting at condenser end; and service valves for both suction and liquid lines.
   5. Terminate suction and liquid refrigerant piping with service valves within unit.
   6. Low Ambient Control: Cycles fans and modulates condenser fan damper assembly to permit operation down to 0 deg F.
   7. Coil Guard: Painted galvanized steel with louvered grilles.

2.9 INTEGRAL AIR-COOLED CONDENSER FOR UNITS 15 TONS AND SMALLER

A. Description: Factory assembled and tested; consisting of condenser coil, fans and motors, and cabinet.
   1. Condenser Coil: Aluminum-fin copper tube with integral subcooler; leak tested to 425 psig.
   2. Condenser Fan: Direct-drive propeller type with permanently lubricated motor with built-in thermal-overload protection.
3. Low Ambient Control: Cycles fans to permit operation down to 0 deg F.

2.10 REFRIGERATION SYSTEM

A. Description: Factory assembled and tested, and charged with HCFC-free refrigerant; consisting of piping and accessories connecting compressor, evaporator coil, and condenser coil, and including the following:

1. Four-way reversing valve and suction-line accumulator.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant dryer.
4. High-pressure switch.
5. Low-pressure switch.
6. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
7. Low ambient switch.
8. Brass service valves installed in discharge and liquid lines.

2.11 HEATING COIL

A. Steam Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.

B. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

2.12 AIR FILTERS

A. Extended-Surface, Disposable Panel Filters: 2-inch thick, dry, filters with fibrous media material formed into deep-V-shaped pleats and held by self-supporting wire grid holding frames, with nonflammable cardboard media and media-grid frame.

B. Air-Pressure Switch: Indicates dirty filters.
2.13 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

B. Control Package: Factory wired, including contactor, high- and low-pressure cutouts, internal-winding thermostat for compressor, control-circuit transformer, and noncycling reset relay.

C. Time-Delay Relay: Five-minute delay to prevent compressor cycling.

D. Adjustable Thermostat: Remote to control the following:
   1. Supply fan.
   2. Compressor.
   3. Condenser.
   4. Hot-water coil valve.
   5. Steam coil valve.


F. Fan Control Switch: Auto-on.

G. Time Clock: Cycle unit on and off.

H. Microprocessor Control Panel: Controls unit functions, including refrigeration and safety controls, and the following:
   1. Supply fan.
   2. Supply-fan motor speed.
   3. Compressors.
   5. Cooling tower pump.
   7. Modulating, steam coil valve.
   8. Multistep, electric heater.
   9. Time-of-day control to cycle unit on and off.
   10. Night-heat, morning warm-up cycle.

I. Microprocessor Control Panel: Controls unit functions, including refrigeration and safety controls, and the following:
1. Supply fan.
2. Supply-fan motor speed.
3. Economizer control.
5. Air-cooled condenser.
6. Cooling tower pump.
7. Modulating, hot-water coil valve.
8. Modulating, steam coil valve.
9. Multistep, electric heater.
10. Panel-mounted control switch to operate unit in remote or local control mode, or to stop or reset.
11. Panel-mounted indication of the following:
   a. Operating status.
   b. System diagnostics and safety alarms.
   c. Supply-air temperature set point.
   d. Zone heating-temperature set point.
   e. Supply-air pressure set point.
   f. Economizer minimum position set point.
   g. Supply-air-pressure, high-limit set point.
   h. Monitor constant and variable motor loads.
   i. Monitor variable frequency drive operation.
   j. Monitor economizer cycle.
   k. Monitor cooling load.
   l. Monitor air distribution static pressure and ventilation air volumes.

12. Time-of-day control to cycle unit on and off.

J. Additional Monitoring for Units 15 Tons and Smaller:

1. Monitor constant and variable motor loads.
2. Monitor variable frequency drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.
2.14 VENTILATION OPTIONS FOR UNITS 15 TONS AND SMALLER

A. Barometric Outside-Air Damper: Adjustable-blade damper allowing induction of up to 25 percent outside air when evaporator fan is running.

B. Motorized Outside-Air Damper: Motorized, two-position blade damper allowing induction of up to 25 percent outside air; with spring-return, low-voltage damper motor.

C. Economizer: Damper assembly allowing induction of up to 100 percent outside air to maintain a selected mixed-air temperature; and exhaust damper and spring-return, low-voltage, modulating damper motor with minimum position adjustment.

D. Energy-Recovery Ventilator: Assembly of desiccant-coated, heat-recovery wheels and centrifugal exhaust fans to transfer approximately 67 percent of the difference between the sensible and latent heat of outside and exhaust air.

2.15 ECONOMIZER OPTIONS FOR UNITS LARGER THAN 15 TONS

A. Air-Side Economizer: Damper assembly allowing induction of up to 100 percent outside air to maintain a selected mixed-air temperature; and exhaust damper and spring-return, low-voltage, modulating damper motor with minimum position adjustment.

B. Water-Side Economizer: Mechanically cleanable, aluminum-fin, copper-tube coil assembly, two four rows deep, allowing precooling of inlet air using condenser water; with piping and bypass control valves.

END OF SECTION 238119
COMPUTER-ROOM AIR-CONDITIONERS
SECTION 238123 - COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Floor-mounted computer-room air conditioners, 6 tons and larger.
   2. Floor-mounted computer-room air conditioners, 5 tons and smaller.
   3. Ceiling-mounted computer-room air conditioners.
   4. Console computer-room air conditioners.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1

D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

E. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.

F. Factory quality-control and test reports.

G. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

E. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Factory quality-control and test reports.
G. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED UNITS 6 TONS AND LARGER

A. Manufacturers: Subject to compliance with requirements, provide products by the following
   1. Liebert. (Basis of Design)

   Products from other manufacturers require NYPH-OFO approval.

B. Description: Packaged, factory assembled, prewired, and pre-piped; consisting of cabinet, fans, filters, humidifier, and controls.

C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.
   2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch-thick duct liner.
   3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors. Retain subparagraph below for downflow units; delete for upflow units.
   5. Floor Stand: Welded tubular steel, <Insert required height> high, with adjustable legs and vibration isolation pads.

D. Supply-Air Fan(s):
   1. Double-inlet, forward curved centrifugal fan(s); statically and dynamically balanced.
2. Drive: V-belt, with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.

E. Refrigeration System:

1. Compressors: Hermetic scroll; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.

2. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.

3. Refrigerant: R-407 or R-410A Refrigerant:
   a. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
      a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.


5. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel and disconnect switch. Control capacity by modulating fan speeds.

6. Three-way refrigerant bypass with receiver and isolation valve.

7. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
8. Water-Side Economizer: Cupronickel tube and aluminum fin coil leak tested at 400 psig with 3-way valve and entering-water temperature sensor and controller. Valve diverts water to waterside economizer coil ahead of refrigerant-to-water heat exchanger when entering-water temperature falls to 55 deg F. Verify availability of water regulating valves and motorized water valves.

9. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.

10. Motorized Water Valve: Stop water flow through the unit when compressor is off.

F. Remote, Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, multiple direct-drive propeller fans with fan guards, and single-phase motors with internal overload protection and integral electric control panel. Control capacity by cycling fans.

1. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

G. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing two centrifugal pump(s) with mechanical seals; electrical-control cabinet with starters, lead-lag switch, automatic switchover, and alarm light.

1. Piping: Interconnecting piping, to and from remote, air-cooled, glycol-solution cooler, with shutoff valves, flow switches, check valves in pump discharge, unions, and pressurized expansion tank with air purge vent and system-charging connection.

2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 F.

3. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

H. Refrigerant Heating Coil: Hot-gas coil of seamless copper tubes expanded into aluminum fins with three-way solenoid valve on first-stage refrigerant circuit.

I. Hot-Water Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve and strainer.

1. Control Valve: Class 125 body.
a. Maximum Pressure Drop: 5 psig at design flow rate.

b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

J. Steam Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve, strainer, and float-and-thermostatic trap.

1. Control Valve: Class 125 body.

   a. Maximum Pressure Drop (15-psig Steam): 80 percent of inlet steam pressure.

   b. Close-Off (Differential) Pressure Rating: 150 percent of operating (inlet) pressure.

K. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame with 2-inch-thick, disposable, glass-fiber pre-filter.

1. Thickness: 4 inches.

2. Initial Resistance: 0.27 inches w.c.

3. Recommended Final Resistance: 0.60 inches w.c.

4. Arrestance (ASHRAE 52.1): 90 percent.

5. Merv (ASHRAE 52.2): 7

L. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.

2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.

3. Drain Cycle: Field-adjustable drain duration and drain interval.

M. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.
N. Disconnect Switch:  Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

O. Electronic-Control System:  Solid state, with start button, stop button, temporary loss of power indicator, manual-reset circuit breakers, temperature control, humidity control, and monitor panel.

1. Monitor Panel:  Backlighted, with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of airflow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).

2. Temperature- and Humidity-Control Modules:  Solid state, plug-in; with adjustable set point, push-to-test calibration check button, and built-in visual indicators to show mode of operation.

3. Location:  Behind hinged door in front of unit; isolated from conditioned airstream to allow service while system is operating.

P. Microprocessor-Control System:  Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem.  If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.

1. Malfunctions:
   a. Power loss.
   b. Loss of airflow.
   c. Clogged air filter.
   d. High room temperature.
   e. Low room temperature.
   f. High humidity.
   g. Low humidity.
   h. Smoke/fire.
   i. Water under floor.
   j. Supply fan overload.
   k. Compressor No. 1 - Overload.
   l. Compressor No. 1 - Low Pressure.
   m. Compressor No. 1 - High Pressure.
   n. Compressor No. 2 - Overload.
2. Digital Display:
   a. Control power on.
   b. Humidifying.
   c. Dehumidifying.
   d. Compressor No. 1 - Operating.
   e. Compressor No. 2 - Operating.
   f. Heat operating.
   g. Economy cooling.

3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.

4. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.
   a. ASHRAE 135 BACnet or LonTalk or Modbus industry-accepted, open-protocol Communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

2.2 FLOOR-MOUNTED UNITS 5 TONS AND SMALLER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Data Aire
   2. Liebert Corp.
   3. Stulz-ATS.

B. Description: Self-contained, factory assembled, prewired, and pre-piped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.

C. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1-inch-thick duct liner.
1. Floor Stand: Welded tubular steel, <Insert required height> high, with adjustable legs and vibration isolation pads.
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Supply-Air Fan: Forward curved, centrifugal, and with adjustable V-belt drive.

E. Refrigeration System:
   1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
   2. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
   3. Refrigerant: R-407C or R-410A.
   4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins, with two circuits, each with solenoid valve.
      a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
   5. Integral, Water-Cooled Refrigerant Condenser: Brazed-plate type with liquid-line stop valve and head-pressure-actuated, two-way regulating valve. Materials of construction exposed to condenser water to be cupronickel.
   7. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

F. Water-Side Economizer: Cupronickel tube and aluminum fin coil leak tested at 400 psig with 3-way valve and entering-water temperature sensor and controller. Valve diverts water to water-side economizer coil ahead of refrigerant-to-water heat exchanger when entering-water temperature falls to 55 deg F. Verify availability of water regulating valves and motorized water valves.
1. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.

2. Motorized Water Valve: Stop water flow through the unit when compressor is off.

G. Remote Air-Cooled, Glycol-Solution Cooler: Corrosion-resistant cabinet, copper-tube aluminum-fin coil, direct-drive propeller fan with fan guards, and single-phase motors with internal overload protection.

1. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

H. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.

1. Piping: Interconnecting piping, from suction to discharge, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.

2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F.

3. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

I. Filter: 2-inch-thick, disposable, glass-fiber media.

1. Initial Resistance: 0.3 inches w.c.

2. Recommended Final Resistance: 0.6 inches w.c.

3. Arrestance (ASHRAE 52.1): 90 percent.

4. Merv (ASHRAE 52.2): 7

J. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.

3. Drain Cycle: Field-adjustable drain duration and drain interval.

K. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

L. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- and humidity-control modules, humidity contactor, time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

2.3 CEILING-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Liebert Corporation.
   2. Stulz-ATS.

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches.

C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch-thick duct liner.
   1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches, with filter.
   2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.

E. Refrigeration System:
   1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.

3. Refrigerant: Refrigerant: R-407C or R-410A.

4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
   a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.

5. Integral, Water-Cooled Refrigerant Condenser: Coaxial, counterflow, tube-in-tube brazed-plate type with liquid-line stop valve and head-pressure-actuated, water-regulating valve. Materials of construction exposed to condenser water to be cupronickel

OR


7. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

F. Water-Side Economizer: Cupronickel tube and aluminum fin coil leak tested at 400 psig with 3-way valve and entering-water temperature sensor and controller. Valve diverts water to water-side economizer coil ahead of refrigerant-to-water heat exchanger when entering-water temperature falls to 55 deg F
   1. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.
   2. Motorized Water Valve: Stop water flow through the unit when compressor is off.


H. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.
1. Piping: Interconnecting piping, to and from remote, air-cooled glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.

2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F.

I. Filter: 1-inch thick, disposable, glass-fiber media.

   1. Initial Resistance: 0.23 inches w.c.
   2. Recommended Final Resistance: 0.5 inches w.c.
   3. Arrestance (ASHRAE 52.1): 90 percent.
   4. Merv (ASHRAE 52.2): 7

J. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.

   1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
   2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
   3. Drain Cycle: Field-adjustable drain duration and drain interval.

K. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

L. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature-and humidity-control modules, humidity contactor, time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

2.4 CONSOLE UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Liebert Corporation.
   2. Stulz-ATS.
B. Description: Split system consisting of evaporator section for floor or wall mounting and remote condensing section.

C. Evaporator Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans and two-speed motor.
   1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Condenser Cabinet: Steel with baked-enamel finish and containing compressor and condenser.

E. Refrigeration System:
   1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
   2. Refrigeration Circuit: Filter/dryer, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
   3. Refrigerant: R-407C or R-410A.
   4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
      a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
   7. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

F. Water-Side Economizer: Cupronickel tube and aluminum fin coil leak tested at 400 psig with 3-way valve and entering-water temperature sensor and controller. Valve diverts water to water-side economizer coil ahead of refrigerant-to-water heat exchanger when entering-
water temperature falls to 55 deg F. Verify availability of water regulating valves and motorized water valves.

1. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.

2. Motorized Water Valve: Stop water flow through the unit when compressor is off.


H. Glycol-Solution Pump Package: Weatherproof and vented enclosure of enameled, galvanized steel on structural base frame containing centrifugal pump with mechanical seal.

   1. Piping: Interconnecting piping, to and from remote, air-cooled, glycol-solution cooler, with shutoff valves, flow switches, unions, and pressurized expansion tank with air purge vent and system-charging connection.

   2. Glycol: Inhibited ethylene glycol and water solution mixed 50:50, suitable for operating temperature of minus 40 deg F.

I. Filter: Cleanable.

J. Filter: 1-inch thick, disposable, glass-fiber media.

   1. Initial Resistance: 0.23 inches w.c.

   2. Recommended Final Resistance: 0.5 inches w.c.

   3. Arrestance (ASHRAE 52.1): 90 percent.

   4. Merv (ASHRAE 52.2): 7

K. Electrode Steam Humidifier: Self-contained and microprocessor controlled; with replaceable cylinder.

L. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

M. Control System: Unit-mounted panel with contactors, control transformer with circuit breaker, and solid-state temperature- and humidity-control modules. Provide solid-state, unit-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.
2.5 FAN MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.6 CAPACITIES AND CHARACTERISTICS

A. Unit Configuration:
   1. Upflow or Downflow.
   2. Draw or Blow through.

B. Supply-Air Fan:
   1. Number of Fans: One

C. Refrigeration System:
   1. Unit Energy Efficiency: <Insert COP or EER>.
   2. Refrigerant Compressor:
      a. Total Unit Cooling Capacity: <Insert Btu/h>.
      b. Sensible Unit Cooling Capacity: <Insert Btu/h>.
      c. Number of Compressors: One Two <Insert number>.
      d. Motor Size: <Insert number> hp.
   3. Refrigerant Evaporator Coil:
      a. Cooling Capacity: <Insert Btu/h>.
      b. Entering-Air Dry-Bulb Temperature: <Insert deg F>.
      c. Entering-Air Wet-Bulb Temperature: <Insert deg F>.
4. Water-Cooled Refrigerant Condenser:
   a. Cooling Capacity: <Insert Btu/h>.
   d. Entering-Water Temperature: <Insert deg F>.
   e. Fluid Pressure Drop: <Insert feet of head>.

OR

5. Air-Cooled Refrigerant Condenser:
   a. Cooling Capacity: <Insert Btu/h>.
   b. Entering-Air Temperature: <Insert deg F>.
   c. Number of Condenser Fan Motors: <Insert number>.
   d. Condenser Fan Motors: <Insert number> hp.

D. Hydronic Cooling Coil:
   1. Cooling Coil Capacity: <Insert Btu/h>.
   2. Entering-Air Dry-Bulb Temperature: <Insert deg F>.
   4. Leaving-Air Dry-Bulb Temperature: <Insert deg F>.
   5. Leaving-Air Wet-Bulb Temperature: <Insert deg F>.

E. Remote, Air-Cooled, Glycol-Solution Cooler:
   1. Cooling Coil Capacity: <Insert Btu/h>.
   2. Entering-Air Temperature: <Insert deg F>.
   5. Entering-Glycol Temperature: <Insert deg F>.
   6. Number of Fans: <Insert number>.
   7. Fan Motors: <Insert number> hp.
8. Number of Pumps: <Insert number>.

F. Hydronic Heating Coil:
1. Total: <Insert Btu/h>.
2. Entering-Air Dry-Bulb Temperature: <Insert deg F>.
3. Leaving-Air Dry-Bulb Temperature: <Insert deg F>.
5. Entering-Water Temperature: <Insert deg F>.
7. Fluid Pressure Drop: <Insert feet of head>.

G. Steam Heating Coil:
1. Total: <Insert Btu/h>.
2. Entering-Air Dry-Bulb Temperature: <Insert deg F>.
3. Leaving-Air Dry-Bulb Temperature: <Insert deg F>.
5. Steam Pressure: <Insert psig>.

H. Electric-Resistance Heating Coil:
1. Total Capacity: <Insert kW>.
2. Stages of Heating: 1 2<Insert number>.

I. Humidifier:
1. Total: <Insert lb/h>.
2. Input: <Insert Btu/h>.

J. Electrical Characteristics:
1. Volts: 120 208 240 277 480 <Insert value>
3. Hertz: 60.
5. Minimum Circuit Ampacity: <Insert value>. 

END OF SECTION 238123
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.
D. Factory quality-control and test reports.

E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

G. LEED Submittals:

1. Credit EA 4: Manufacturers' product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Stultz ATS
2. Cool Air
3. Daiken-McQuay.
4. Mitsubishi Electric
5. Sanyo Fisher (U.S.A.) Corp..

2.2 CONCEALED EVAPORATOR-FAN COMPONENTS

A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

1. Insulation: Faced, glass-fiber duct liner.
2. Drain Pans: Galvanized steel, with connection for drain; insulated.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
C. Water or Steam Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.

D. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

E. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

F. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

G. Disposable Filters: 1 inch thick, in fiberboard frames.

H. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.3 FLOOR-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enamel steel with removable panels on front and ends in color selected by Architect.
   1. Discharge Grille: Steel with surface-mounted frame
   2. Insulation: Faced, glass-fiber, duct liner.
   3. Drain Pans: Galvanized steel, with connection for drain; insulated.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Water or Steam Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a 2-position control valve.

D. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset
thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

E. Fan: Direct drive, centrifugal with power-induced outside air.

F. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

G. Filters: Permanent, cleanable.

2.4 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal fan.

E. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.5 CEILING-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

D. Fan: Direct drive, centrifugal fan, with power-induced outside air, and integral condensate pump.

E. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable.

2.6 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Scroll.
   2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   3. Refrigerant Charge: R-407C or R-410A
   4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.

C. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

D. Fan: Aluminum-propeller type, directly connected to motor.
E. Motor: Permanently lubricated, with integral thermal-overload protection.

F. Low Ambient Kit: Permits operation down to 45 deg F.

G. Mounting Base: Polyethylene.

2.7 WATER-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, with baked-enamel finish in color selected by Architect, removable panels for access to controls, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Scroll.

2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

3. Refrigerant Charge: R-407C or R-410A Retain first paragraph below for heat pump units.

C. Heat Pump Components: Reversing valve.

D. Heat Exchanger: Copper tubes in copper tube or in steel shell, with water-temperature-actuated, water-regulating valve.

2.8 ACCESSORIES

A. Thermostat: Low voltage with sub-base to control compressor and evaporator fan.

B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.

2. 24-hour time control of system stop and start.

3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

4. Fan-speed selection, including auto setting.
C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Additional Monitoring:
   1. Monitor constant and variable motor loads.
   2. Monitor variable frequency drive operation.
   3. Monitor economizer cycle.
   4. Monitor cooling load.
   5. Monitor air distribution static pressure and ventilation air volumes.

END OF SECTION 238126
VALANCE HEATING AND COOLING UNITS
SECTION 238213 - VALANCE HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following:
      1. Electric radiant heaters.
      2. Prefabricated electric radiant heating panels.
      3. Hydronic heating and cooling panels.

1.3 DEFINITIONS
   A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

1.4 SUBMITTALS
   A. Product Data: Include rated capacities, specialties, and accessories for each product indicated.
   B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Suspended ceiling components.
2. Structural members to which heaters and suspension systems will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
5. Perimeter moldings.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. For Radiant Heater Finishes: [4 by 4 inches] <Insert size>.
2. For Radiant Panel Finishes: [12 by 12 inches] <Insert size>.

F. Manufacturer Seismic Qualification Certification: Submit certification that suspended radiant heaters and panels, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Field quality-control test reports.
H. Operation and Maintenance Data: For electric radiant heaters and panels to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION
A. Coordinate layout and installation of radiant heaters and panels and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 ELECTRIC RADIANT HEATERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Berko Electric Heating; a division of Marley Engineered Products.
   2. Chromalox Inc.; a division of Emerson Electric Company.
   3. Fostoria Industries, Inc.; a division of TPI Corporation.
   4. Markel Products; a division of TPI Corporation.
   5. QMark Electric Heating; a division of Marley Engineered Products.

B. Quartz Lamp Heating Elements: Coiled tungsten-wire heating element enclosed in clear quartz tube.

C. Quartz Tube Heating Elements: Nickel-chromium-wire heating element enclosed in quartz tube.


E. Comply with [UL 499] [and] [UL 2021].
F.  Enclosures:  [Aluminized] [Stainless] [Painted]-steel housing with anodized-aluminum reflector.
   1.  Finish:  Baked-enamel finish in manufacturer's [standard] [custom] paint color as selected by Architect.

G.  Unit Controls:
   1.  Line-voltage thermostat.
   2.  Enclosed contactor for remote thermostat.
   3.  Snow and ice detector with moisture sensor and integral temperature sensor.

H.  Capacities and Characteristics:
   1.  Enclosure Length:  <Insert inches.>
   2.  Mounting Height:  <Insert feet.>
   3.  Heating Capacity:  <Insert kW.>
   4.  Radiation Pattern:  [30] [60] [90] <Insert number> [symmetric] [asymmetric]-degree-included angle.
   5.  Electrical Characteristics for Single-Point Connection:
      a.  Volts:  <Insert value.>
      b.  Phase:  <Insert value.>
      c.  Hertz:  <Insert value.>
      d.  Full-Load Amperes:  <Insert value.>
      e.  Minimum Circuit Ampacity:  <Insert value.>
      f.  Maximum Overcurrent Protection:  <Insert value.>

2.2  PREFABRICATED ELECTRIC RADIANT HEATING PANELS

A.  Available Manufacturers:  Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B.  Manufacturers:  Subject to compliance with requirements, provide products by one of the following:

C.  Basis-of-Design Product:  Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer’s name; product name or designation> or a comparable product by one of the following:
1. Berko Electric Heating; a division of Marley Engineered Products.
2. Markel Products; a division of TPI Corporation.
3. QMark Electric Heating; a division of Marley Engineered Products.

D. Description: Sheet-metal-enclosed panel with heating element suitable for [lay-in installation flush with T-bar ceiling grid] [surface mounting] [recessed mounting]. Comply with UL 2021.

1. Panel: Minimum 0.0276-inch- thick, galvanized-steel sheet back panel riveted to minimum 0.0396-inch- thick, galvanized-steel sheet front panel with fused-on crystalline surface.
2. Heating Element: Powdered graphite sandwiched between sheets of electric insulation.
4. Electrical Connections: Nonheating, high-temperature, insulated-copper leads, factory connected to heating element.
8. Surface-Mounting Trim: Sheet metal with baked-enamel finish in manufacturer's [standard] [custom] paint color as selected by Architect.

E. Wall Thermostat: Bimetal, sensing elements calibrated from 55 to 90 deg F; with contacts suitable for [low] [line]-voltage circuit, and manually operated on-off switch with contactors, relays, and control transformers.

F. Capacities and Characteristics:

1. Nominal Panel Size: [24 by 24 inches] [24 by 36 inches] [24 by 48 inches] [24 by 60 inches] <Insert custom size>.
2. Heating Capacity: [250] [375] [500] [570] [625] [750] [950] <Insert value> kW.
3. Electrical Characteristics for Single-Point Connection:
   a. Volts: <Insert value.> 
   b. Phase: <Insert value.> 
   c. Hertz: <Insert value.> 
   d. Full-Load Amperes: <Insert value.> 
   e. Minimum Circuit Ampacity: <Insert value.> 
   f. Maximum Overcurrent Protection: <Insert value.>
2.3 HYDRONIC HEATING[ AND COOLING] PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Rosemex Products.

B. Description: [Modular] [Linear] sheet metal panel with serpentine water piping, suitable for [lay-in installation flush with T-bar ceiling grid] [surface mounting] [recessed mounting].
   1. Panels: Minimum [0.0336-inch- thick, galvanized-steel] [0.0396-inch- thick, aluminum] sheet.
   2. Backing Insulation: Minimum [1-inch-] [2-inch-] <Insert thickness> thick, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory-applied jacket.
   5. Exposed-Side Panel Finish: Baked-enamel finish in manufacturer's [standard] [custom] paint color as selected by Architect.
   6. Factory Piping: [ASTM B 88, Type L] [ASTM B 88, Type M] copper tube with ASME B16.22 wrought-copper fittings and brazed joints. Piping shall be mechanically bonded to panel.
   7. Surface-Mounting Trim: Sheet metal with baked-enamel finish in manufacturer's [standard] [custom] paint color as selected by Architect.
   8. Accessories:
      a. [5-inch] [6-inch] [8-inch] panel with drape track recess.
      b. 5-inch male bullnose panel.
      c. 5-inch female bullnose panel.
      d. 4-inch male corner panel.
      e. 4-inch female corner panel.
      f. Inside corner panel.
      g. 1/2-inch filler panel.

C. Capacities and Characteristics:

1. Nominal Panel Size: [24 by 24 inches] [24 by 36 inches] [24 by 48 inches] [24 by 60 inches] <Insert custom size>.
2. Piping Inlet and Outlet: [NPS 1/2] <Insert size>.
3. Heating:
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a. Capacity:  <Insert Btu/h.>  
b. Room Temperature:  <Insert deg F.>  
c. Entering-Water Temperature:  <Insert deg F.>  
d. Average Water Temperature:  <Insert deg F.>  
e. Water Flow:  <Insert gpm.>  
f. Water-Side Pressure Loss:  <Insert psig.>

4. Cooling:  
a. Sensible Capacity:  <Insert Btu/h.>  
b. Dry-Bulb Room Temperature:  <Insert deg F.>  
c. Wet-Bulb Room Temperature:  <Insert deg F.>  
d. Entering-Water Temperature:  <Insert deg F.>  
e. Average Water Temperature:  <Insert deg F.>  
g. Water-Side Pressure Loss:  <Insert psig.>

PART 3 - EXECUTION

3.1 EXAMINATION  
A. Examine areas to receive radiant heating and cooling units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for [hydronic piping] [electrical] connections to verify actual locations before radiant heating and cooling unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION  
A. Install radiant heating and cooling units level and plumb.

B. Suspend radiant heaters from structure.

C. Support for Radiant Heating and Cooling Panels in or on Grid-Type Suspended Ceilings: Use grid as a support element.
1. Install a minimum of four ceiling support system rods or wires for each panel. Locate not more than 6 inches from panel corners.

2. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.

3. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support panels independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on panel. Wire or rod shall have breaking strength of the weight of panel at a safety factor of 3.

D. Verify locations of thermostats with Drawings and room details before installation. Install devices [48 inches] [60 inches] <Insert dimension> above finished floor.

### 3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.

C. Install piping adjacent to unit to allow service and maintenance.

D. Ground electric units according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports:

1. Operate electric heating elements through each stage to verify proper operation and electrical connections.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.

B. Remove and replace malfunctioning units and retest as specified above.
C. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain radiant heaters and panels. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238213
AIR COILS
SECTION 238216 - AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of air coils that are not an integral part of air-handling units:

1. Hot-water.
2. Chilled-water.
3. Steam.
4. Refrigerant.
5. Electric.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Factory quality-control and test reports.

D. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

E. Warranty

F. Provide access doors before and after coils.
PART 2 - PRODUCTS

2.1 WATER COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerofin Corporation.
2. Carrier Corporation.
4. McQuay
5. York Corp.

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.035 inch.

F. Fins: Aluminum, minimum 0.010 inch thick and maximum 11 per inch.

G. Headers: Cast iron with drain and air vent tappings. Cast iron with cleaning plugs, and drain and air vent tappings. Seamless copper tube with brazed joints, prime coated. Steel with brazed joints, prime coated.

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in flanged mounting.

I. Hot-Water Coil and Steam Coil, Face-and-Bypass Dampers: Alternating arrangement of coil segments and dampers.

2. Dampers: Extruded-aluminum blades with edge and end seals; full-length drive rod and mount for actuator outside the airstream.
J. Hot-Water Coil Capacities and Characteristics:

1. Coil Face Dimensions:
   a. Finned Length: <Insert inches.>
   b. Finned Width: <Insert inches.>

2. Minimum Fin Spacing: 0.091 inch
3. Tube Diameter: 0.625 inch
4. Number of Rows:
7. Coating: Baked phenolic Cathodic epoxy e-coat.
8. Air Side:
   a. Flow Rate: <Insert cfm.>
   b. Finned Area Face Velocity: <Insert fpm.>
   c. Static Pressure Drop: <Insert inches wg.>
   d. Total Capacity: <Insert Btu/h.>
   e. Entering Temperature: <Insert deg F.>
   f. Leaving Temperature: <Insert deg F.>

9. Water Side:
   a. Flow Rate: <Insert gpm.>
   b. Tube Velocity: <Insert fpm.>
   c. Glycol Type: Ethylene Propylene.
   d. Aqueous Glycol Solution Concentration: <Insert percentage.>
   e. Pressure Drop: <Insert feet.>
   f. Entering Temperature: <Insert deg F.>
   g. Leaving Temperature: <Insert deg F.>

K. Chilled-Water Coil Capacities and Characteristics:

1. Coil Face Dimensions:
   a. Finned Length: <Insert inches.>
   b. Finned Width: <Insert inches.>

2. Minimum Fin Spacing: 0.091 inch
3. Tube Diameter: 0.625 inch  
   Number of Rows: Minimum 6.
5. Mounting: Slip in Flanged.
7. Air Side:
   a. Flow Rate: <Insert cfm.>
   b. Finned Area Face Velocity: <Insert fpm.>
   c. Static Pressure Drop: <Insert inches wg.>
   d. Total Capacity: <Insert Btu/h.>
   e. Sensible Capacity: <Insert Btu/h.>
   f. Entering Dry-Bulb Temperature: <Insert deg F.>
   g. Entering Wet-Bulb Temperature: <Insert deg F.>
   h. Leaving Dry-Bulb Temperature: <Insert deg F.>
   i. Leaving Wet-Bulb Temperature: <Insert deg F.>
8. Water Side:
   a. Flow Rate: <Insert gpm.>
   b. Tube Velocity: <Insert fpm.>
   c. Glycol Type: Ethylene Propylene.
   d. Aqueous Glycol Solution Concentration: <Insert percentage.>
   e. Pressure Drop: <Insert feet.>
   f. Entering Temperature: <Insert deg F.>
   g. Leaving Temperature: <Insert deg F.>

2.2 STEAM COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerofin Corporation.
   2. Carrier Corporation.
   4. McQuay
   5. York Corp.

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
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C. Minimum Working-Pressure/Temperature Ratings: 100 psig, 400 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: 1” dia. ASTM B 743 copper, minimum 0.049 inch thick.

F. Fins: Aluminum minimum 0.010 inch thick.

G. Headers: Seamless copper tube with brazed joints, prime coated tube Type: Non-freeze steam distributing

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

Retain paragraph and subparagraphs below for face-and-bypass coils.

I. Face-and-Bypass Dampers: Preheat coils shall be integral face and bypass design (Alternating arrangement of coil segments and dampers).

2. Dampers: Extruded-aluminum blades with edge and end seals; full-length drive rod and mount for an actuator outside the airstream.

J. Capacities and Characteristics:

1. Coil Face Dimensions:
   a. Finned Length: <Insert inches.>
   b. Finned Width: <Insert inches.>

2. Minimum Fin Spacing 0.091 inch
3. Tube Diameter: 0.75 inch 0.049” thick
4. Number of Rows: <Insert number.>
6. Air Side:
   a. Flow Rate: <Insert cfm.>
   b. Finned Area Face Velocity: <Insert fpm.>
   c. Static Pressure Drop: <Insert inches wg.>
   d. Total Capacity: <Insert Btu/h.>
   e. Entering Temperature: <Insert deg F.>
f. Leaving Temperature: <Insert deg F.>

7. Steam Side:
   a. Inlet Pressure: <Insert psig.>
   b. Tube Type: Distributing.
   c. Condensing Capacity: <Insert lb/h.>

2.3 REFRIGERANT COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerofin Corporation.
   2. Carrier Corporation.
   4. York Corp..

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure Rating: 300 psig.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum 0.035 inch thick.

F. Fins: Aluminum minimum 0.010 inch thick.

G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

I. Capacities and Characteristics:
   1. Coil Face Dimensions:
      a. Finned Length: <Insert inches.>
      b. Finned Width: <Insert inches.>
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2. Minimum Fin Spacing: 0.091 inch
3. Tube Diameter: 0.625 inch
4. Number of Rows: <Insert number.>
5. Coil Split: Interlaced
7. Coating: Cathodic epoxy e-coat.
8. Air Side:
   a. Flow Rate: <Insert cfm.>
   b. Finned Area Face Velocity: <Insert fpm.>
   c. Static Pressure Drop: <Insert inches wg.>
   d. Total Capacity: <Insert Btu/h.>
   e. Sensible Capacity: <Insert Btu/h.>
   f. Entering Dry-Bulb Temperature: <Insert deg F.>
   g. Entering Wet-Bulb Temperature: <Insert deg F.>
   h. Leaving Dry-Bulb Temperature: <Insert deg F.>
   i. Leaving Wet-Bulb Temperature: <Insert deg F.>

9. Refrigerant Side:
   a. Refrigerant Type: <Insert type.>
   b. Saturated Suction Temperature: <Insert deg F.>

2.4 ELECTRIC COILS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

   1. Brasch Manufacturing Co., Inc.
   2. Chromalox, Inc., Wiegand Industrial Division; Emerson Electric Company.
   3. INDEECO.
   4. Trane.
D.  Coil Assembly:  Comply with UL 1995.

E.  Heating Elements:  Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.

F.  High-Temperature Coil Protection:  Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.

1.  Secondary Protection:  Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

G.  Frames:  Galvanized-steel channel frame, minimum 0.0625 inch thick flanged mounting.

H.  Control Panel:  Unit mounted with disconnecting means and overcurrent protection.  Include the following controls:

1.  Magnetic contactor.
3.  Toggle switches; one per step.
4.  Step controller.
5.  Time-delay relay.
6.  Pilot lights; one per step.
7.  Airflow proving switch.

I.  Thermostats:  Wall-mounted thermostats, with temperature range from 50 to 90 deg F, and 2.5 deg F throttling range.

J.  Capacities and Characteristics:

1.  Coil Face Dimensions:
   a.  Length:  <Insert inches.>
   b.  Height:  <Insert inches.>


3.  Air Side:
   a.  Flow Rate:  <Insert cfm.>
   b.  Face Velocity:  <Insert fpm.>
c. Static Pressure Drop: <Insert inches wg.>
d. Total Capacity: <Insert Btu/h.>
e. Entering Temperature: <Insert deg F.>
f. Leaving Temperature: <Insert deg F.>

4. Electrical Characteristics:
   a. Capacity: <Insert kW.>
   b. Number of Steps: <Insert number.>
   c. Volts: <Insert value.>
   d. Phase: <Insert value.>
   e. Hertz: <Insert value.>
   g. Minimum Circuit Ampacity: <Insert value.>
   h. Maximum Overcurrent Protection: <Insert amperage.>

END OF SECTION 238216
FAN COIL UNITS
SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes fan-coil units and accessories.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


C. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Factory quality-control and test reports.

E. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
F. Warranty: Special warranty specified in this Section.

PART 2 - PRODUCTS

2.1 FAN-COIL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
   1. Carrier Corporation.
   3. McQuay
   4. YORK International Corporation.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1-inch thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

   1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Main and Auxiliary Drain Pans Stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62. Drain pans shall be removable.

E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect

   1. Vertical Unit Front Panels: Removable, steel, with steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
   2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with cast-aluminum discharge grilles.
   3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from
manufacturer's standard colors. Return grille shall provide maintenance access to fan-coil unit.

4. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

G. Outdoor-Air Wall Box: Minimum 0.1265-inch-thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.
   1. Louver Configuration: Horizontal, rain-resistant louver.
   2. Louver Material: Aluminum
   5. Finish: Baked enamel, color as selected by Architect from manufacturer's standard colors.

H. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic, two-position actuators.

I. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

J. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

K. Steam Coils: Copper distributing tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig.

L. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

M. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

N. Factory, Hydronic Piping Package: ASTM B 88, Type M copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
   1. modulating control valve for chilled-water coil.
   2. modulating control valve for heating coil.
   3. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
      a. Length: 24 inches.
      b. Minimum Diameter: Equal to fan-coil-unit connection size.

4. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

5. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250-deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.

6. Y-Pattern Hydronic Strainers: Cast-iron body ASTM A 126, Class B; 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.


8. Risers: ASTM B 88, Type M copper pipe with hose and ball valve for system flushing.

O. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" and

P. Basic Unit Controls:
   1. Control voltage transformer.
   2. Unit-mounted thermostat with the following features:
      b. Fan on-auto switch.
      c. Fan-speed switch.
      e. Adjustable deadband.
      f. Exposed set point.
g. Exposed indication.
h. Degree F indication.

3. Wall-mounting Unit-mounted humidistat.
   a. Exposed set point.
   b. Exposed indication.

4. Unit-mounted temperature sensor.
5. Unoccupied-period-override push button.
6. Data entry and access port.
   a. Input data includes room temperature, and humidity set points and occupied and
      unoccupied periods.
   b. Output data includes room temperature and humidity, supply-air temperature,
      entering-water temperature, operating mode, and status.

Q. DDC Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a
   minimum of four programmable periods per day.
2. Unoccupied Period Override Operation: Two hours.
3. Unit Supply-Air Fan Operation:
   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:
   a. Occupied Periods: Modulate control valve to maintain room temperature.
   b. Unoccupied Periods: Close control valve.

5. Heating-Coil Operation:
   a. Occupied Periods: Modulate control valve Energize electric-resistance coil to
      provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and modulate control valve energize electric-
      resistance coil if room temperature falls below setback temperature.

6. Dual-Temperature Hydronic-Coil Operation:
Fan Coil Units

a. Occupied Periods: When chilled water is available, modulate control valve if room temperature exceeds thermostat set point. When hot water is available, open control valve if temperature falls below thermostat set point.

b. Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, modulate control valve if room temperature falls below thermostat setback temperature.

c. Occupied Periods:

1) Heating Operations: Modulate control valve Energize electric-resistance coil to provide heating if room temperature falls below thermostat set point.

2) Humidity-Control Operations: Humidistat modulates control valve energizes electric-resistance coil to provide heating. As space temperature rises above the set point, cooling coil valve modulates to maintain room temperature.

d. Unoccupied Periods: Start fan and modulate control valve energize electric-resistance coil if room temperature falls below setback temperature. Humidity control is not available.

7. Outdoor-Air Damper Operation:

a. Occupied Periods: Open damper to fixed position for 25 percent outdoor air.

b. Unoccupied periods: Close damper.

8. Controller shall have volatile-memory backup.

R. BAS Interface Requirements:

1. Interface relay for scheduled operation.

2. Interface relay to provide indication of fault at the central workstation.

3. Provide BACnet or LonWorks interface for central BAS workstation for the following functions:

   a. Adjust set points.
   b. Fan-coil-unit start, stop, and operating status.
   c. Data inquiry, including outdoor-air damper position, supply- and room-air temperature and humidity.
   d. Occupied and unoccupied schedules.

S. Electrical Connection: Factory wire motors and controls for a single electrical connection.
T. Capacities and Characteristics:

1. Fan:
   a. Airflow: <Insert cfm.>
   b. External Static Pressure: <Insert inches wg.>
   c. Fan Speed: <Insert rpm.>
   d. Motor Speed: <Insert rpm.>
   e. Motor Horsepower: <Insert horsepower.>

2. Cooling Capacity:
   a. Total: <Insert Btu/h.>
   b. Sensible: <Insert Btu/h.>
   c. Entering-Air Dry-Bulb Temperature: <Insert deg F.>
   d. Entering-Air Wet-Bulb Temperature: <Insert deg F.>

3. Chilled-Water Coil:
   b. Water-Side Pressure Loss: <Insert feet wg.>
   c. Entering-Water Temperature: <Insert deg F.>

4. Heating Capacity:
   a. Output: <Insert Btu/h.>
   b. Entering-Air Temperature: <Insert deg F.>
   c. Air-Temperature Rise: <Insert deg F.>

5. Hot-Water Heating Coil:
   b. Water-Side Pressure Loss: <Insert feet wg.>
   c. Entering-Water Temperature: <Insert deg F.>

6. Steam Heating Coil:
   a. Inlet Steam Pressure: <Insert psig.>
   b. Condensing Capacity: <Insert lb/h.>

7. Electric-Resistance Heating Coil:
Fan Coil Units

2.2 DUCTED FAN-COIL UNITS

A. Basis-of-Design Product: a product by one of the following:
1. Carrier Corporation.
3. Trane.
4. YORK International Corporation.

B. Description: Factory-packaged and tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1-inch thick foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Drain Pans: Stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62.

E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

F. Cabinets: Steel with baked-enamel finish in manufacturer’s standard paint color.

1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille.
2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

I. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and brazed joints at fittings. Comply with ARI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve.
J. Steam Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig.

K. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

L. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

1. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

M. Factory, Hydronic Piping Package: ASTM B 88, Type M copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

   1. modulating control valve for chilled-water coil.
   2. modulating control valve for heating coil.
   3. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

      a. Length: 24 inches
      b. Minimum Diameter: Equal to fan-coil-unit connection size.

   4. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
   5. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
   6. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
   7. Y-Pattern Hydronic Strainers: Cast-iron body ASTM A 126, Class B; 125-psig working pressure, with threaded connections, bolted cover, perforated stainless-steel
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basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.


N. Remote Condensing Units: Factory assembled and tested, consisting of compressors, condenser coils, fans, motors, refrigerant receiver, and operating controls. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.

1. Casing: Steel with baked-enamel finish, removable panels for access to controls, weep holes for water drainage, and mounting holes in base.

2. Compressor: Hermetic, scroll type; internally isolated for vibration with factory-installed safety devices as follows:
   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss-of-charge switch.
   d. Internal thermal-overload protection.
   e. Current and voltage sensitive safety devices.

3. Compressor Motor: Start capacitor, relay, and contactor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."


6. Low ambient controls to permit operation down to 45 deg F.

7. Crankcase heater.

8. Charging and service fittings on exterior of casing.


10. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat operation.

11. Hot-gas-bypass, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.


   a. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

14. Accessories: Polyethylene mounting base to provide a permanent foundation.
Control devices and operational sequence are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

P. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounting or Unit-mounted thermostat with the following features.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.
3. Wall-mounting or Unit-mounted humidistat.
   a. Exposed set point.
   b. Exposed indication.
4. Wall-mounting or Unit-mounted temperature sensor.
5. Unoccupied-period-override push button.
6. Data entry and access port.
   a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
   b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

Q. DDC Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied Period Override Operation: Two hours.
3. Unit Supply-Air Fan Operation:
   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
4. Hydronic-Cooling-Coil Operation:
   a. Occupied Periods: Modulate control valve to maintain room temperature.
   b. Unoccupied Periods: Close control valve.

5. Refrigerant-Coil Operation:
   a. Occupied Periods: Start compressor to maintain room temperature or humidistat set point.
   b. Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.

6. Supplemental Heating-Coil Operation:
   a. Occupied Periods Modulate control valve or Energize electric-resistance coil to provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and modulate control valve energize electric-resistance coil if room temperature falls below setback temperature.
   c. Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below 25 deg F

7. Dual-Temperature Hydronic-Coil Operation:
   a. Occupied Periods: When chilled water is available, modulate control valve if room temperature exceeds thermostat set point. When hot water is available, modulate control valve if temperature falls below thermostat set point.
   b. Unoccupied Periods: When chilled water is available, close valve. When hot water is available, modulate control valve if room temperature falls below thermostat setback temperature.
   c. Occupied Periods:
      1) Heating Operations: Modulate control valve Energize electric-resistance coil to provide heating if room temperature falls below thermostat set point.
      2) Humidity-Control Operations: Humidistat modulates control valve energizes electric-resistance coil to provide heating. As room temperature rises above the set point, cooling coil valve modulates to maintain room temperature.
d. Unoccupied Periods: Start fan and modulate control valve energize electric-resistance coil if room temperature falls below setback temperature. Humidity control is not available.

8. Outdoor-Air Damper Operation:
   a. Occupied Periods: Open damper to fixed position for 25 percent outdoor air.
   b. Unoccupied Periods: Close damper.

R. BAS Interface Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide BACnet or LonWorks interface for central BAS workstation for the following functions:
   a. Adjust set points.
   b. Fan-coil-unit start, stop, and operating status.
   c. Data inquiry including outdoor-air damper position, supply- and room-air temperature and humidity.
   d. Occupied and unoccupied schedules.

S. Electrical Connection: Factory wire motors and controls for a single electrical connection.

T. Capacities and Characteristics:

1. Fan:
   a. Airflow: <Insert cfm.>
   b. Static Pressure: <Insert inches wg.>
   c. Fan Speed: <Insert rpm.>
   d. Motor Speed: <Insert rpm.>
   e. Motor Horsepower: <Insert horsepower.>
   f. Drive: Direct Belt.

2. Cooling Capacity:
   a. Total: <Insert Btu/h.>
   b. Sensible: <Insert Btu/h.>
   c. Entering-Air Dry-Bulb Temperature: <Insert deg F.>
   d. Entering-Air Wet-Bulb Temperature: <Insert deg F.>
3. Chilled-Water Coil:
   b. Water-Side Pressure Loss: <Insert feet wg.>
   c. Air-Side Pressure Drop: <Insert inches wg.>
   d. Entering-Water Temperature: <Insert deg F.>

4. Refrigerant Coil:
   a. Air-Side Pressure Loss: <Insert inches wg.>
   b. Suction Temperature: <Insert deg F.>

5. Condensing Unit:
   a. Compressor Power Input: <Insert kW.>
   c. Seasonal Energy-Efficiency Ratio: <Insert value.>
   d. Coefficient of Performance: <Insert value.>
   e. Voltage/Phase/Hertz: <Insert values.>
   g. Maximum Circuit Amperes: <Insert value.>
   h. Maximum Overcurrent Protection: <Insert value.>

6. Heating Capacity:
   a. Output: <Insert Btu/h.>
   b. Entering-Air Temperature: <Insert deg F.>
   c. Air-Temperature Rise: <Insert deg F.>

7. Hot-Water Heating Coil:
   b. Water-Side Pressure Loss: <Insert feet wg.>
   c. Air-Side Pressure Drop: <Insert inches wg.>
   d. Entering-Water Temperature: <Insert deg F.>

8. Steam Heating Coil:
   a. Air-Side Pressure Drop: <Insert inches wg.>
   b. Inlet Steam Pressure: <Insert psig.>
   c. Condensing Capacity: <Insert lb/h.>
9. Electric-Resistance Heating Coil:
   a. Capacity: <Insert kW.>
   b. Number of Steps: <Insert number.>

10. Reheat Capacity:
    a. Output: <Insert Btu/h.>
    b. Entering-Air Temperature: <Insert deg F.>
    c. Air-Temperature Rise: <Insert deg F.>

11. Hot-Water Reheat Coil:
    b. Water-Side Pressure Loss: <Insert feet wg.>
    c. Air-Side Pressure Drop: <Insert inches wg.>
    d. Entering-Water Temperature (during Cooling): <Insert deg F.>

12. Steam Reheat Coil:
    a. Air-Side Pressure Drop: <Insert inches wg.>
    b. Inlet Steam Pressure: <Insert psig.>
    c. Condensing Rate: <Insert lb/h.>

13. Electric-Resistance Reheat Coil:
    a. Capacity: <Insert kW.>
    b. Number of Steps: <Insert number.>
14. Filters:
   a. Face Area: <Insert sq. ft.>
   b. Thickness: 1 inch 2 inches <Insert thickness>.

15. Electrical Characteristics for Single-Point Connection:
   a. Voltage/Phase/Hertz: <Insert values.>
   b. Full-Load Amperes: <Insert values.>
   c. Maximum Circuit Amperes: <Insert values.>
   d. Maximum Overcurrent Protection: <Insert values.>

END OF SECTION 238219
UNIT VENTILATORS
PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes unit ventilators and accessories with the following heating and cooling features:

1. Hydronic Steam Electric heating coil.
2. Hydronic Steam Electric reheat coil.
3. Hydronic Direct-expansion refrigerant cooling coil.

1.2 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Comply with minimum COP/efficiency levels according to ASHRAE/IESNA 90.1.

1.3 FACILITY OPERATIONS REQUIREMENTS
A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
C. Manufacturer Seismic Qualification Certification: Submit certification that unit ventilators, accessories, and components will withstand seismic forces defined in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”

D. Field quality-control test reports.

E. Operation and Maintenance Data: For unit ventilators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

F. Warranty: Special warranty specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation.
2. Trane.

2.2 MANUFACTURED UNITS

A. Description: Factory-packaged and -tested units rated according to ARI 840, ASHRAE 33, and UL 1995, including finished cabinet, filter, cooling coil, drain pan, supply-air fan and motor in blow- or draw-through configuration, and hydronic cooling coil.

2.3 CABINETS

A. Insulation: Minimum 1-inch thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

B. Drain Pans: Insulated galvanized steel with plastic liner, formed to slope from all directions to the drain connection as required by ASHRAE 62. Drain pan shall be removable.

C. Cabinet Frame and Access Panels: Welded-steel frame with removable panels fastened with hex-head tamperproof fasteners and key-operated control and valve access doors.

1. Steel components exposed to moisture shall be hot-dip galvanized after fabrication.

D. Cabinet Finish: Baked enamel, in manufacturer's standard paint color as selected by Architect.

E. Indoor-Supply-Air Grille: adjustable linear bar.

F. Return-Air Inlet: Front toe space

G. End Panels: Matching material and finish of unit ventilator.

H. Outdoor-Air Wall Box: Minimum 0.1265-inch- thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.

1. Louver Configuration: Horizontal Vertical rain-resistant louver.
2. Louver Material: Aluminum
5. Finish: Baked enamel, color as selected by Architect from manufacturer's standard colors.

2.4 COILS

A. Test and rate unit ventilator coils according to ASHRAE 33.

B. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

C. Steam Coils: Copper distributing tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig.
D. Electric-Resistance Heating Coils: Nickel-chromium heating wire or tubular elements in coil fins, free of expansion noise and hum, with fuses in terminal box for overcurrent protection, and continuous limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

E. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and brazed joints at fittings. Comply with ARI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve.

2.5 INDOOR FAN

A. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels; and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Fan Shaft and Bearings: Hollow steel shaft with permanently lubricated, resiliently mounted bearings.
   4. Wiring Termination: Connect motor to chassis wiring with plug connection.

2.6 DAMPERS

A. Mixing Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric actuator.

B. Outdoor-Air Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with electric actuator.

C. Face and Bypass Dampers: Galvanized-steel damper blades with edge and end seals and nylon bearings; with factory-mounted electric actuator.
2.7 ACCESSORIES

A. Exhaust Shutter: Barometric type designed to limit room pressure to maximum 0.10-inch wg with aluminum damper blades including edge and end seals, in galvanized-steel frame with outdoor and interior wall grille.

B. Subbase: Sheet metal floor-mounting base with leveling screws and black enamel finish.

C. Insulated false back with gasket seals on wall and outdoor-air plenum.
   1. Insulation: Minimum 1-inch thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
      a. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Return-air plenum, 6 inches thick, designed to take return air from top inlet grilles in cabinets on both sides of unit ventilator with gasket seals on wall and outdoor-air plenum extension.

E. Duct flanges for supply-, return-, and outdoor-air connections.

F. Radiation Grille: linear-bar grille with finish to match discharge-air grille.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

H. Energy Recovery Wheel:
   1. Casing: Steel with manufacturer’s standard paint coating and with the following:
      a. Integral purge section.
      b. Casing seals on periphery of rotor, on duct divider, and on purge section.
      c. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
   2. Rotor: Corrugated-aluminum, segmented wheel strengthened with radial spokes, and having nontoxic, noncorrosive silica-gel desiccant coating. Construct media for passing maximum 800-micrometer solids and maximum 0.04 percent cross contamination by volume of exhaust air. Drive rotor with belt around outside of rotor.
3. Defrost Coils: Electric defrost coil in the exhaust airstream.
4. Drive: Fractional horsepower motor and gear reducer, with speed changed by adjustable variable frequency controller.
5. Inlet and Discharge Fans: Forward curved, centrifugal; resiliently mounted with flexible duct connections.
   a. Motor and Drive: Permanently lubricated, direct driven. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
6. Filters: 1-inch-thick, disposable type, mounted in galvanized-steel frame upstream of energy recovery wheel in both supply and exhaust airstreams.
7. Electrical: Single electrical connection from attached unit ventilator.

2.8 FACTORY HYDRONIC PIPING PACKAGE

A. Piping: ASTM B 88, Type L ASTM B 88, Type M copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet. Crossover piping, NPS 1-1/2 NPS 2 with shutoff valves.

B. Control Valves: Electric actuators compatible with terminal controller and building controls.
   1. Modulating control valve for chilled-water coil.
   2. Modulating control valve for hot-water heating coil.
   3. Modulating control valve for hot-water reheat coil.

C. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
   1. Length: 24 inches 36 inches <Insert dimension>.
   2. Minimum Diameter: Equal to unit ventilator connection size.

D. Isolation Valves, Strainers, Unions, and Balance Valves:
   1. Two-Piece Ball Valves: Bronze body with stainless-steel ball and stem and galvanized-steel lever handle for each supply and return connection. If balancing device is combination shutoff type with memory stop, isolation valve may be omitted on the return.
   2. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or
venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.

3. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F, with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.

4. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.


2.9 REMOTE CONDENSING UNITS

A. Description: Factory assembled and tested; consisting of compressors, condenser coils, fans, motors, refrigerant receiver, and operating controls. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.

B. Casing: Steel with baked-enamel finish; removable panels for access to controls, weep holes for water drainage, and mounting holes in base.

1. Casing Finish: Baked enamel, in manufacturer's standard paint color as selected by Architect.

C. Compressor: Hermetic, scroll type; internally isolated for vibration with factory-installed safety devices as follows:

1. Antirecycle timer.
2. High-pressure cutout.
3. Low-pressure cutout or loss-of-charge switch.
4. Internal thermal-overload protection.

D. Compressor Motor: Start capacitor, relay, and contactor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

E. Refrigerant Piping Materials:

1. Drawn-Temper Copper Tube: ASTM B 88, Type L.
2. Annealed-Temper Copper Tube: ASTM B 88, Type L ASTM B 88, Type K.

F. Charge: R-407C R-410A refrigerant.

G. Low ambient controls to permit operation down to 45 deg F.

H. Crankcase heater.

I. Charging and service fittings on exterior of casing.

J. Filter dryer.

K. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat.

L. HGBP, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.

M. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.

N. Condenser Fan: Direct-drive, aluminum propeller fan; motor with thermal-overload protection.

1. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

O. Accessories: Polyethylene mounting base to provide a permanent foundation.

2.10 INTEGRAL COOLING CHASSIS

A. Description: Assembly mounted within unit ventilator, factory assembled and tested; consisting of compressors, condenser coils, fans, motors, and refrigerant receivers; removable for maintenance, with plug and receptacle connections for control and power wiring. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.

B. Casing: Galvanized steel with removable panels for access to controls and refrigerant piping.


D. Compressor: Hermetic, scroll type; internally isolated for vibration with factory-installed safety devices as follows:
1. Antirecycle timer.
2. High-pressure cutout.
3. Low-pressure cutout or loss-of-charge switch.
4. Internal thermal-overload protection.

E. Refrigerant Piping Materials:

1. Drawn-Temper Copper Tube: ASTM B 88, Type L.
2. Annealed-Temper Copper Tube: ASTM B 88, Type L ASTM B 88, Type K.

F. Charge: R-407C R410A refrigerant.

G. Low ambient controls to permit operation down to 45 deg F.

H. Crankcase heater.

I. Charging and service fittings.

J. Filter dryer.

K. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat.

L. HGBP, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.

M. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.

N. Direct-Driven Condenser Fan: Forward curved, double width, centrifugal; thermoplastic or painted-steel wheels and galvanized-steel fan scrolls.

1. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.11 BASIC UNIT CONTROLS

A. Basic Unit Controls:

1. Control voltage transformer.
2. Unit-mounted thermostat with the following features.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.

3. Unit-mounted humidistat.
   a. Exposed set point.
   b. Exposed indication.

4. Unit-mounted temperature sensor.

5. Unoccupied-period-override push button.

6. Data entry and access port.
   a. Input data includes room temperature and humidity set points, and occupied and unoccupied periods.
   b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

B. DDC Terminal Controller:

   1. Safety Controls Operation: Freezestat shall stop fan and close outdoor-air damper if air less than 38 F enters coils.
   2. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
   3. Unoccupied Period Override Operation: Two hours.
   4. Dual-Temperature Coil Operation:
      a. Occupied Periods: When chilled water is available, modulate control valve if room temperature exceeds thermostat set point. When hot water is available, modulate control valve if room temperature falls below thermostat set point.
      b. Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, modulate control valve if room temperature falls below thermostat setback temperature.
5. Hydronic Cooling-Coil Operation:
   a. Occupied Periods: Modulate control valve to provide cooling if room
temperature exceeds thermostat set point.
   b. Unoccupied Periods: Close control valve.

6. Refrigerant-Coil Operation:
   a. Occupied Periods: Start compressor to maintain room temperature.
   b. Unoccupied Periods: Cycle compressor for heating to maintain setback
temperature.

7. Supplemental Heating-Coil Operation:
   a. Occupied Periods: Modulate control valve Energize electric-resistance coil to
provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and modulate control valve energize electric-
resistance coil if room temperature falls below setback temperature.
   c. Switch refrigerant-reversing valve to operate supplemental coil for heating when
outdoor temperature is below 25 deg F

8. Reheat-Coil Operation:
   a. Humidity Control for Occupied Periods: Humidistat modulates control valve
energizes electric-resistance coil to provide heating. As room temperature rises
above the set point, cooling coil valve modulates to maintain room temperature.
   b. Humidity Control for Unoccupied Periods: Close control valve

Outdoor-Air Damper Operation: Open to 25 percent fixed minimum intake, and
maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II during
occupied periods, and close during unoccupied periods. Microprocessor controller
shall permit air-side economizer operation when outdoor air is less than 60 deg F

Carbon Dioxide Sensor Operation: During occupied periods, reset minimum outdoor-
air ratio down to minimum 10 percent to maintain maximum 800-ppm <Insert
concentration> concentration.

9. Face-and-Bypass Damper Operation: Position damper to face of coils until room
temperature equals thermostat set point; bypass after room-temperature set point is
achieved.


11. HGBP: Open HGBP solenoid valve to maintain minimum suction pressure at
compressor.
12. Controller shall have volatile-memory backup.

C. BAS Interface Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide BACnet or LonWorks interface for central BAS workstation for the following functions:
   a. Adjust set points.
   b. Unit ventilator start, stop, and operating status.
   c. Data inquiry to include outdoor-air damper position, supply- and room-air temperature and humidity.
   d. Occupied and unoccupied schedules.

D. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.12 METAL SHELVES AND CABINETS

A. Include manufacturer's standard cabinets to match unit ventilators with required installation hardware as indicated:

1. Open Shelving with Reinforced Shelves:
   a. Return-air plenum Radiation enclosure and aluminum bar grille with finish to match unit ventilator grille.
   b. Through-piping enclosure with solid top.

2. Closed Shelving with Reinforced Shelves:
   a. Return-air plenum Radiation enclosure and aluminum bar grille with finish to match unit ventilator grille.
   b. Through-piping enclosure with solid top.
   c. Two sliding doors with key-operated locks.

3. Utility compartment with access panel with key-operated lock.
4. Wall and corner filler sections, and end panels finished to match shelving.

B. Painted Finish: Manufacturer's standard baked enamel, in color selected by Architect, applied to shelving before shipping.
C. Cabinet Top: Plastic-laminate top in color and pattern selected by Architect from manufacturer's standard colors.

2.13 CAPACITIES AND CHARACTERISTICS

A. Fan:
   1. Airflow: <Insert cfm.>
   2. External Static Pressure: <Insert inches wg.>
   3. Fan Speed: <Insert rpm.>

B. Cooling Capacity:
   1. Total: <Insert Btu/h.>
   2. Sensible: <Insert Btu/h.>
   3. Entering-Air Dry-Bulb Temperature: <Insert deg F.>
   4. Entering-Air Wet-Bulb Temperature: <Insert deg F.>

C. Chilled-Water Coil:
   2. Water-Side Pressure Loss: <Insert feet wg.>
   3. Entering-Water Temperature: <Insert deg F.>

D. Refrigerant Coil:
   1. Suction Temperature: <Insert deg F.>

E. Condensing Unit:
   1. Ambient Temperature: <Insert deg F.>
   2. Compressor Power Input: <Insert kW.>
   5. Coefficient of Performance: <Indicate value.>
   6. Voltage/Phase/Hertz: <Insert values.>
   7. Full-Load Amperes: <Insert value.>
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F. Heating Capacity:
   1. Output: <Insert Btu/h.>
   2. Entering-Air Temperature: <Insert deg F.>
   3. Air-Temperature Rise: <Insert deg F.>

G. Hot-Water Heating Coil:
   2. Water-Side Pressure Loss: <Insert feet wg.>
   3. Entering-Water Temperature: <Insert deg F.>

H. Steam Heating Coil:
   1. Inlet Steam Pressure: <Insert psig.>
   2. Condensing Capacity: <Insert lb/h.>

I. Electric-Resistance Heating Coil:
   1. Capacity: <Insert kW.>
   2. Number of Steps: <Insert number.>

J. Reheat Capacity:
   1. Output: <Insert Btu/h.>
   2. Entering-Air Temperature: <Insert deg F.>
   3. Air-Temperature Rise: <Insert deg F.>

K. Hot-Water Reheat Coil:
   2. Water-Side Pressure Loss: <Insert feet wg.>
   3. Entering-Water Temperature (during Cooling): <Insert deg F.>

L. Steam Reheat Coil:
   1. Inlet Steam Pressure: <Insert psig.>
   2. Condensing Rate: <Insert lb/h.>

M. Electric-Resistance Reheat Coil:
   1. Capacity: <Insert kW.>
2. Number of Steps: <Insert number.>
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N. Filters:
   1. Type: Washable foam Coated Glass fiber Pleated cotton-polyester media.
   3. Thickness: 1 inch 2 inches <Insert thickness>.

O. Energy Recovery Exhaust:
   1. Airflow: <Insert cfm.>
   2. Entering-Air Dry-Bulb Temperature: <Insert deg F.>
   3. Entering-Air Wet-Bulb Temperature: <Insert deg F.>
   4. Leaving-Air Dry-Bulb Temperature: <Insert deg F.>
   5. Leaving-Air Wet-Bulb Temperature: <Insert deg F.>

P. Energy Recovery Outdoor Air:
   1. Airflow: <Insert cfm.>
   2. Entering-Air Dry-Bulb Temperature: <Insert deg F.>
   3. Entering-Air Wet-Bulb Temperature: <Insert deg F.>
   4. Leaving-Air Dry-Bulb Temperature: <Insert deg F.>
   5. Leaving-Air Wet-Bulb Temperature: <Insert deg F.>

Q. Energy Recovery Wheel:
   2. Drive Motor Horsepower: <Insert horsepower.>

R. Electrical Characteristics for Single-Point Connection:
   1. Voltage/Phase/Hertz: <Insert values.>
   2. Full-Load Amperes: <Insert value.>

END OF SECTION 238223
CONVECTORS
SECTION 238233 - CONVECTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hydronic Steam Electric baseboard radiators.
3. Hydronic Steam Electric convectors.
4. Flat-pipe steel radiators.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Details of custom-fabricated enclosures indicating dimensions.
3. Location and size of each field connection.
4. Location and arrangement of piping valves and specialties.
5. Location and arrangement of integral controls.
6. Enclosure joints, corner pieces, access doors, and other accessories.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Berko Electric Heating; a division of Marley Engineered Products.
   2. Chromalox; a division of Emerson Electric Company.
   3. Indeeco.
   4. Markel Products; a division of Marley Engineered Products.

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.
   1. Volts: <Insert value.>
   2. Phase: <Insert value.>
   3. Hertz: <Insert value.>

D. Enclosures: Minimum - 0.0428-inch-thick steel, removable front cover.

E. Rust-Resistant Enclosures: Minimum -0.052-inch-thick ASTM A 653/A 653M, G60 galvanized-steel, removable front cover.
   1. Full-height back.
   2. Full-length damper.
   3. End panel.
   4. Plastic end caps.
   5. Inside and outside corners.
   6. Joiner pieces to snap together.
   7. Enclosure Height: <Insert inches.
   8. Enclosure Depth: <Insert inches.
10. Element Brackets: Primed and painted steel to support front panel and element.

F. Unit Controls: Integral electronic thermostat

G. Accessories:
   1. Filler sections without a heating element matching the adjacent enclosure.
   2. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

2.2 HOT-WATER OR STEAM BASEBOARD RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Rittling, a div. of Hydro-Air Components.
   2. Slant/Fin.
   3. Sterling
   4. Vulcan

B. Performance Ratings: Rate baseboard radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on polypropylene element glides. One end of tube shall be belled.

   1. Tube Diameter NPS 1
   2. Fin Size 3 by 3 inches
   3. Fin Spacing: 40 per foot.
   4. Number of Tiers: <Insert number.>
   6. Entering Air Temperature: 65 deg F
   7. Retain two subparagraphs below for hot-water radiators.
   8. Average Water Temperature: 170 deg F
   9. Minimum Water Velocity: 1/2 fps

Retain subparagraph below for steam radiators.
Entering Steam Pressure: 1 psig

D. Heating Elements: Steel tubing mechanically expanded into flanged collars of evenly spaced steel fins resting on polypropylene element glides. Tube ends shall be threaded.

1. Tube Diameter: NPS 1
2. Fin Size: 3 by 3 inches
3. Fin Spacing: 52 per foot
4. Number of Tiers: <Insert number.>
6. Entering Air Temperature: 65 deg F
7. Average Water Temperature: 170 deg F
8. Minimum Water Velocity: 1/2 fps
9. Entering Steam Pressure: 1 psig

E. Enclosures: Minimum - 0.0428-inch-thick steel, removable front cover.

F. Rust-Resistant Enclosures: Minimum 0.052-inch-thick ASTM A 653/A 653M, G60 galvanized-steel, removable front cover.

1. Full-height back.
2. Full-length damper.
3. End panel.
4. End caps.
5. Inside and outside corners.
6. Valve access door.
7. Joiner pieces to snap together.
8. Enclosure Height: <Insert inches.
10. Finish: Baked-enamel finish in manufacturer’s standard custom color as selected by Architect.
11. Element Brackets: Primed and painted steel to support front panel and element.

2.3 ELECTRIC FINNED-TUBE RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chromalox; a division of Emerson Electric Company.
2. Indeeco.
3. Markel Products; a division of TPI Corporation.
B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded into fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

1. Volts: <Insert value.>
2. Phase: <Insert value.>
3. Hertz: <Insert value.>

D. Rust-Resistant Front Panel: Minimum 0.052-inch thick ASTM A 653/A 653M, G60 galvanized steel.

E. Floor-Mounting Pedestals: Conceal conduit for power and control wiring at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel.

F. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

G. Finish: Baked-epoxy finish in manufacturer’s standard color as selected by Architect.

H. Damper: Knob-operated internal damper at enclosure outlet.

I. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

J. Enclosure Style: Sloped Flat top.

1. Front Inlet Grille: Punched louver; painted to match enclosure.
2. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
   b. Anodized finish color as selected by Architect from manufacturer’s standard colors.
   c. Painted to match enclosure.

3. Front Outlet Grille: Punched louver; painted to match enclosure.
b. Anodized finish color as selected by Architect from manufacturer's standard colors.

c. Painted to match enclosure.

5. Enclosure Height: <Insert inches.

K. Unit Controls: Integral line-voltage thermostat with minimum range of 60 to 90 deg F

Accessories: Integral disconnect switch, filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

2.4 HOT-WATER OR STEAM FINNED-TUBE RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Rittling, a div. of Hydro-Air Components.
2. Slant/Fin.

B. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube Commercial Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One tube end shall be belled.

1. Tube Diameter: NPS 1
2. Fin Size: 4 by 4 inches
3. Fin Spacing: 40 per foot
4. Number of Tiers: <Insert number.>
6. Entering Air Temperature: 65 deg F
7. Retain two subparagraphs below for hot-water radiators.
8. Average Water Temperature: 170 deg F
9. Minimum Water Velocity: 1/2 fps

D. Heating Elements: Steel tubing mechanically expanded into flanged collars of evenly spaced steel fins resting on element supports. Tube ends shall be threaded.

1. Tube Diameter: NPS 1-1/4
2. Fin Size: 4 by 4 inches <
3. Fin Spacing: 52 per foot
4. Number of Tiers: <Insert number.>
6. Entering Air Temperature: 65 deg F

Average Water Temperature: 170 deg F

Minimum Water Velocity: 1/2 fps

E. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

F. Rust-Resistant Front Panel: Minimum 0.052-inch-thick, ASTM A 653/A 653M, G60 galvanized steel.

G. Floor-Mounting Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.

H. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

I. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.

J. Damper: Knob-operated internal damper at enclosure outlet.

K. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

L. Enclosure Style: Sloped top.
   1. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      b. Anodized finish, color as selected by Architect from manufacturer's standard colors.
      c. Painted to match enclosure.
   2. Front Outlet Grille: Punched louver; painted to match enclosure.
   3. Front Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      b. Anodized finish, color as selected by Architect from manufacturer's standard colors.
      c. Painted to match enclosure.
4. Enclosure Height: <Insert inches>
5. Enclosure Depth: <Insert inches>

M. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

2.5 ELECTRIC CONVECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Berko Electric Heating; a division of Marley Engineered Products.
2. Chromalox; a division of Emerson Electric Company.
3. Indeeco.
4. Markel Products; a division of TPI Corporation.

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded into fins, with high-temperature cutout and sensor running the full length of element. Element supports shall eliminate thermal expansion noise.

1. Volts: <Insert value.>
2. Phase: <Insert value.>
3. Hertz: <Insert value.>

D. Front and Top Panel: Minimum 0.0528-inch-thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.

E. Floor-Mounting Pedestals: Conceal conduit for power and control wiring at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel.

F. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

G. Insulation: 1/2-inch-thick, fibrous glass on inside of the back of the enclosure.

H. Finish: Baked-enamel finish in manufacturer’s standard color as selected by Architect.

I. Damper: Knob-operated internal damper.
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J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

K. Enclosure Style: Flat top.
   1. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      b. Anodized finish, color as selected by Architect from manufacturer's standard custom colors.
      c. Painted to match enclosure.

2. Front Outlet Grille: Punched louver; painted to match enclosure.
3. Front Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
   b. Anodized finish, color as selected by Architect from manufacturer's standard custom colors.
   c. Painted to match enclosure.

4. Enclosure Height: <Insert inches>
5. Enclosure Depth: <Insert inches>
6. Enclosure Length: <Insert inches>

L. Unit Controls: Integral line-voltage thermostat with minimum range of 60 to 90 deg F.

M. Accessories: Integral disconnect switch, recessing flanges finished to match enclosure or overlapping front cover for fully recessed units, and rubber gaskets to seal cabinet at wall.

2.6 HOT-WATER OR STEAM CONVECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Rosemex.
   2. Slant/Fin.
   3. Sterling

B. Convecter Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-iron or brass headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum 100 psig.
   1. Element Height: <Insert inches>
2. Element Depth: <Insert inches. 
3. Element Length: <Insert inches.
4. Entering Air Temperature: 65 deg F 
6. Average Water Temperature: 180 deg F 
7. Temperature Drop: 20 deg F 
9. Heat Output (Square Feet EDR): <Insert EDR.
10. Entering Steam Pressure: 1 psig 

C. Front and Top Panel: Minimum 0.0528-inch- thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.

D. Wall-Mounting Back and End Panels: Minimum 0.0428-inch- thick steel.

E. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

F. Insulation: 1/2-inch- thick, fibrous glass on inside of the back of the enclosure.

G. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.

H. Damper: Knob-operated internal damper.

I. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

J. Enclosure Style: Sloped top.
   1. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      b. Anodized finish, color as selected by Architect from manufacturer's standard colors.
      c. Painted to match enclosure.
   2. Front Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      b. Anodized finish, color as selected by Architect from manufacturer's standard colors.
      c. Painted to match enclosure.
   3. Enclosure Height: <Insert inches.
   4. Enclosure Depth: <Insert inches.
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5. Enclosure Length: <Insert inches.>

2.7 FLAT-PIPE STEEL RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Runtal North America, Inc.

B. Heating Elements: Steel, welded and formed into flat, square, steel header with minimum thickness of 0.109 inches. Include threaded piping and air vent connections.
   1. Working Pressure 128 psig:  0.078 inch.
   2. Tube Height: <Insert inches.>
   3. Tube Depth: <Insert inches.>
   4. Tube Length: <Insert inches.>
   5. Number of Tubes High: <Insert number.>
   6. Number of Tubes Deep: <Insert number.>
   7. Fin Spacing: <Insert inches.>
   8. Fin Depth: <Insert inches.>
   9. Room Air Temperature:  65 deg F)
   11. Average Water Temperature:  170 deg F
   12. Temperature Drop:  20 deg F

C. Mounting: Floor pedestals on maximum spacing of 36 inches.

D. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.

E. Accessories:

1. Steel piping covers finished to match radiator finish.
2. Flexible Expansion Compensation Hoses: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F.
   a. Length: 24 inches <Insert dimension>.
   b. Minimum Diameter: Equal to connection size.

END OF SECTION 238233
UNIT HEATERS
SECTION 238239 - UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with centrifugal fans and hot-water steam electric-resistance heating coils.
2. Propeller unit heaters with hot-water steam electric-resistance heating coils.
3. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Details of anchorages and attachments to structure and to supported equipment.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
5. Location and arrangement of piping valves and specialties.
6. Location and arrangement of integral controls.

C. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
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D. Field quality-control test reports.

E. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

F. Warranty

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation.
   2. Chromalox, Inc.; a division of Emerson Electric Company.
   3. Indeeco.
   4. Markel Products; a division of TPI Corporation.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

C. Coil Section Insulation: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
   1. Thickness: 1 inch.
   2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
   3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
   4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect First option in two subparagraphs below, for thickness of 0.0528 inch, is the equivalent of 16-gage steel; second option, for 0.0677 inch, is the equivalent of 14-gage steel.
   1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-0.0677-inch-thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- 0.0677-inch- thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.

3. Control Access Door: Key operated.

4. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.

5. Extended Piping Compartment: 8-inchwide piping end pocket.

6. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.

7. Outdoor-Air Wall Box: Minimum 0.1265-inch- thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen. Aluminum louver with baked-enamel finish in color selected by Architect from manufacturer’s standard colors.
   a. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic two-position actuators.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Pleated: 90 percent arrestance and 7 MERV.

F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

G. Steam Coil: Copper distributing tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 75 psig.

H. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
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I. Fan and Motor Board: Removable.

1. Fan: Forward curved, high static double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

J. Factory, Hot-Water Piping Package: ASTM B 88, Type M copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet and outlet.

1. Two way, modulating control valve
2. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
   a. Length: 24 inches
   b. Minimum Diameter: Equal to cabinet unit heater connection size.
3. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
4. Calibrated-Orifice Balancing Valves: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connection for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
5. Automatic Flow-Control Valve: Brass or ferrous-metal body, 300-psig working pressure at 250 deg F, with removable, corrosion-resistant, tamperproof, self-cleaning, piston-spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
6. Y-Pattern, Hot-Water Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig minimum working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 threaded pipe and full-port ball valve in strainer drain connection.

K. Basic Unit Controls:

1. Control voltage transformer.
2. Unit-mounted thermostat with the following features.
   b. Fan on-auto switch.
d. Adjustable deadband.
e. Exposed set point.
f. Exposed indication.
g. Deg F indication.

3. Unit-mounted temperature sensor.
4. Unoccupied period override push button.
5. Data entry and access port.
   a. Input data includes room temperature, and occupied and unoccupied periods.
   b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

L. DDC Terminal Controller:
1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied Period Override: Two hours.
3. Unit Supply-Air Fan Operations:
   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain setback room temperature.
4. Heating Coil Operations:
   a. Occupied Periods: Modulate control valve or Energize electric-resistance coil to provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and modulate control valve or energize electric-resistance coil if room temperature falls below setback temperature.
5. Outdoor-Air Damper Operation:
   a. Occupied Periods: Open dampers. Delay damper opening if room temperature is more than three degrees below set point.
   b. Unoccupied Periods: Close damper.
6. Controller shall have volatile-memory backup.

M. BAS Interface Requirements:
1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface shall be BAC-net or Lon-Works compatible for central BAS workstation and include the following functions:
   a. Adjust set points.
   b. Cabinet unit heater start, stop, and operating status.
   c. Data inquiry, including outdoor-air damper position supply-air and room-air temperature.
   d. Occupied and unoccupied schedules.

N. Electrical Connection: Factory wire motors and controls for a single field connection.

O. Capacities and Characteristics:

1. Cabinet:

      1) Top: Flat or sloped.
      2) Air Inlet: Front, extruded-aluminum bar grille.
      3) Air Outlet: Front or top extruded-aluminum bar grille.

   b. Vertical, Surface Mounted: Downflow.
      1) Top: Flat or sloped.
      2) Air Inlet: Front or top extruded-aluminum bar grille.
      3) Air Outlet: Front extruded-aluminum bar grille.

      1) Air Inlet: Front, extruded-aluminum bar grille.
      2) Air Outlet: Front or top extruded-aluminum bar grille.

      1) Air Inlet: Front Top Front or top, punched louver extruded-aluminum bar grille.
      2) Air Outlet: Front, quad louver punched louver extruded-aluminum bar grille.

   e. Vertical, Fully Recessed: Upflow or Downflow.
      1) Air Inlet and Outlet: Front extruded-aluminum bar grille inlet and extruded-aluminum bar grille outlet.
f. Horizontal, Surface Mounted:
   1) Air Inlet: Bottom or front extruded-aluminum bar grille.
   2) Air Outlet: Front or top extruded-aluminum bar grille.

g. Horizontal, Semi-recessed:
   1) Air Inlet: Bottom or front extruded-aluminum bar grille.
   2) Air Outlet: Front or top extruded-aluminum bar grille.

h. Horizontal, Fully Recessed:
   1) Air Inlet and Outlet: Front extruded-aluminum bar grille inlet and extruded-aluminum bar grille outlet.

2. Fan:
   a. Airflow: <Insert cfm.
   b. External Static Pressure: <Insert inches wg.
   c. Fan Speed: <Insert rpm.>
   d. Motor Horsepower: <Insert value.>

3. Heating Capacity:
   a. Output: <Insert Btu/h.
   b. Entering-Air Temperature: <Insert deg F.
   c. Air-Temperature Rise: <Insert deg F.

4. Hot-Water Heating Coil:
   b. Water-Side Pressure Loss: <Insert feet wg.
   c. Entering-Water Temperature: <Insert deg F.

5. Steam Heating Coil:
   a. Inlet Steam Pressure: <Insert psig.
   b. Condensing Capacity: <Insert lb/h.

6. Electric-Resistance Heating Coil:
   a. Capacity: <Insert kW.>
   b. Number of Steps: <Insert number.>
7. Filters:
   a. Face Area: <Insert sq. ft.>
   b. Thickness: 1 inch <Insert thickness>.

8. Electrical Characteristics for Single-Point Connection:
   a. Volts: <Insert value.>
   b. Phase: <Insert value.>
   c. Hertz: <Insert value.>
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
   f. Maximum Overcurrent Protection: <Insert value.>

2.2 PROPELLER UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Airtherm; a Mestek Company.
   2. Ruffneck Heaters; a division of Lexa Corporation.
   3. Trane
   4. Modine

B. Description: An assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and tested propeller unit heater before shipping.

G. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

H. General Coil Requirements: Test and rate hot-water steam propeller unit heater coils according to ASHRAE 33.
I. Hot-Water Coil: Cupronickel tube, minimum 0.031-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 400 psig and a maximum entering-water temperature of 450 deg F with manual air vent. Test for leaks to 600 psig underwater.

J. Steam Coil: Red brass tube, minimum 0.049-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 75 psig.

K. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

L. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

M. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Type: Permanently lubricated, explosion proof multispeed variable speed.

N. Control Devices:

1. Unit-mounted variable fan-speed switch.
2. Unit-mounted thermostat.

O. Capacities and Characteristics

1. Heating Capacity:
   b. Length of Throw: <Insert feet.
   c. Mounting Height: <Insert feet.

2. Water Coil:
   a. Entering-Water Temperature: <Insert deg F.
   b. Temperature Difference: <Insert deg F.
d. Water-Side Pressure Drop: <Insert feet.>

3. Steam Coil:
   a. Inlet Pressure: <Insert psig.
   b. Condensing Capacity: <Insert lb/h.

4. Electric Coil:
   a. Heating Capacity: <Insert kW.>
   b. Number of Steps: <Insert number.>

5. Supply Air:
   a. Airflow: <Insert cfm.
   b. Leaving-Air Temperature: <Insert deg F.
   c. Entering-Air Temperature: <Insert deg F.

6. Fan Motor:
   a. High Speed: <Insert rpm.>
   b. Motor Size: <Insert hp.>

7. Electrical Characteristics for Single-Point Connection:
   a. Volts/Phase/Hertz: <Insert values.>
   b. Full-Load Amperes: <Insert value.>
   c. Minimum Circuit Amperes: <Insert value.>
   d. Maximum Overcurrent Protection: <Insert value.>

2.3 WALL AND CEILING HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Indeeco.
   3. Markel Products; a division of TPI Corporation.

B. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Cabinet:
1. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard custom color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

D. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.


F. Fan: Aluminum propeller directly connected to motor.

1. Motor: Permanently lubricated multispeed. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.

H. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

I. Capacities and Characteristics:

1. Airflow: <Insert cfm.>
2. Fan Speed: <Insert rpm.>
3. Heating Coil: <Insert kW.>
4. Electrical Characteristics for Single-Point Connection:
   a. Volts: <Insert value.>
   b. Phase: <Insert value.>
   c. Hertz: <Insert value.>
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
   f. Maximum Overcurrent Protection: <Insert value.>

END OF SECTION 238239
RADIANT-HEATING HYDRONIC PIPING
SECTION 238316 - RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes radiant heating piping, including pipes, fittings, and piping specialties.

1.2 QUALITY ASSURANCE

A. Comply with ASTM codes and standards applicable to type of piping and fittings used for the project. Hydrostatic pressure testing of installed system shall be as per ANSI B31.9 standard.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: For each type of radiant heating pipe, fitting, manifold, specialty, and control.

1. For radiant heating piping and manifolds, include pressure and temperature rating, oxygen-barrier performance, fire-performance characteristics, and water flow and pressure drop characteristics.

B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

1. Shop Drawing Scale: 1/4 inch = 1 foot
2. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.

3. Perimeter moldings.

C. Operation and Maintenance Data: For radiant heating piping valves and equipment to include in operation and maintenance manuals.
PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Infloor Radiant Heating Inc.
   2. IPEX Inc.
   3. Slant/Fin Corp.
   4. Uponor Wirsbo Co.
   5. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.

B. Pipe Material: PEX plastic according to ASTM F 876.

C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

D. Fittings: ASTM F 1807, metal insert and copper crimp rings.

E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.2 PEX/AL/PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. IPEX Inc.
   2. Uponor Wirsbo Co.

B. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F 1281.

C. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

D. Fittings: ASTM F 1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).

E. Flame-Spread and Smoke-Developed Indexes: 25 and 50 or less, respectively, tested according to ASTM E 84.
F. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

2.3 EPDM PIPE AND FITTINGS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.

C. Pipe Material: Cross-linked EPDM inner and outer tubes.

D. Wall Thickness: Minimum 0.125 inch.

E. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

F. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.

G. Fittings: ASTM F 1807, copper with stainless-steel crimps or clamps.

H. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

2.4 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 1, copper Some plastic modular manifolds do not have main shutoff valves. Each piping loop on manifold has its own supply and return shutoff.

B. Main Shutoff Valves:

1. Factory installed on supply and return connections.
2. Three-piece body.
3. Body: Brass or bronze.
4. Ball: Chrome-plated bronze.
5. Seals: PTFE.
7. Maximum Operating Temperature: 225 deg F.
C. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Key furnished with valve, or screwdriver bit.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 225 deg F.

D. Balancing Valves:
   1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
   2. Ball or Plug: Brass or stainless steel.
   4. Seat: PTFE.
   6. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
   7. CWP Rating: Minimum 125 psig.
   8. Maximum Operating Temperature: 250 deg F.

E. Zone Control Valves:
   1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
   2. Ball or Plug: Brass or stainless steel.
   4. Seat: PTFE.
   5. Actuator: Replaceable electric motor.
   7. Maximum Operating Temperature: 250 deg F.

F. Thermometers:
   1. Mount on supply and return connections.
   2. Case: Dry type, metal or plastic, 2-inch diameter.
   3. Element: Bourdon tube or other type of pressure element.
   4. Movement: Mechanical, connecting element and pointer.
   5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

G. Mounting Brackets: Copper, or plastic or copper-clad steel, where in contact with manifold.

2.5 PIPING SPECIALTIES

A. Cable Ties:
   1. Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   3. Tensile Strength: 20 lb, minimum.
   4. Temperature Range: Minus 40 to plus 185 deg F.

B. Floor-Mounting Staples:
   1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
   3. Width: Minimum, wider than tubing.

C. Floor-Mounting Clamps:
   1. Two bolt, steel, with corrosion-resistant coating and smooth finish without sharp edges.
   3. Width: Minimum, wider than tubing.

D. Floor Mounting Tracks:
   1. Aluminum or plastic channel track with smooth finish, no sharp edges.
   3. Slot Width: Snap fit to hold tubing.
   4. Slot Spacing: 2-inch 3-inch <Insert spacing> intervals.
E. Channeled Subfloor:
   1. Plywood, APA-rated subfloor panel, composed of premium, tongue-and-groove, 7-layer, Douglas fir structural subfloor panels.
   2. Particleboard manufactured to meet Federal Housing Authority standards of less than 0.3-ppm formaldehyde.
   3. Clad panel with minimum 0.025-inch-thick aluminum recessed in the grooves sized to maintain contact with radiant piping.

F. Modular Interlocking Blocks:
   1. Polypropylene snap-together blocks with grooves to support piping.
   2. Galvanized sheet metal or aluminum emission plates.
   3. Natural mineralboard cover panel.

G. Heat-Emission Plates:
   1. Formed aluminum suitable for radiant heating piping.
   3. Slot Width: Snap fit to maintain pressure fit on tubing.

2.6 CONTROLS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Honeywell.
   2. Infloor Radiant Heating Inc.
   3. Slant/Fin Corp.
   4. Tekmar Control Systems, Ltd.
   5. Uponor Wirsbo Co.

C. Wall-Mounting Thermostat:
   1. Minimum temperature range from 50 to 90 deg F <Insert range>.
   2. Manually operated with on-off switch.
   3. Day and night setback and clock program with minimum four periods per day.
4. Operate pumps or open zone control valves if room temperature falls below the thermostat setting, and stop pumps or close zone control valves when room temperature rises above the thermostat setting.

D. Heated-Panel Thermostat:

1. Remote bulb unit with adjustable temperature range from 50 to 90 deg F. 
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.
3. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant panel temperature.
4. Stop pump or close zone control valves if heated-panel thermostat setting is exceeded.
5. Corrosion-resistant, waterproof control enclosure.

E. Heated-Panel Thermostat with Outdoor Temperature Reset:

1. Remote bulb unit with adjustable temperature range from 50 to 90 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump and zone control valve.
3. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant panel temperature.
4. Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing outdoor-air temperature.
5. Operate zone control valves to reset supply-water temperature inversely with outdoor-air temperature as follows:
   a. Low outdoor-air temperature, zero deg F with high supply-water temperature 110 deg F
   b. High outdoor-air temperature, 60 deg F with low supply-water temperature 70 deg F
6. Corrosion-resistant, waterproof control enclosure.

F. Precipitation and Temperature Sensor:

2. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:
   a. Temperature Span: 34 to 44 deg F
b. Adjustable Delay Off Span: 30 to 90 minutes.
c. Start Pump or Open Zone Control Valves: Following two minute delay if ambient temperature is below set point and precipitation is detected.
d. Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to start pump and open valves.
5. Precipitation sensor shall be mounted in pavement.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control system workstation.

END OF SECTION 238316
SECTION 238413 - HUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following humidifiers:

1. Atomizing.
2. Steam injection.
4. Heated pan.
5. Heat exchanger.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.


C. Field quality-control test reports.

D. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

E. Warranty
PART 2 - PRODUCTS

2.1 WATER-PRESSURE ATOMIZING HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hermidifier.

B. Nozzles: ASTM A 666, Type 316 stainless steel.

C. Manifold: ASTM A 269, Type 316 stainless-steel piping.

D. Droplet Filter: Biocide-treated polyethylene with maximum 0.30-inch wg resistance.

E. Piping and Fittings: ASTM A 269, Type 316 stainless-steel pipe and fittings.

F. Piping and Fittings: ASTM B 88, Type L copper pipe and wrought-copper fittings with brazed joints.

G. Water Pump: Enclosed belt-drive ceramic plunger pump with bronze heads, and variable-speed, totally enclosed, fan-cooled motor.

H. Final Water-Filter Efficiency: Minimum 98 percent retention of suspended particles 10 microns and larger from makeup water.

I. Final Water-Filter Pressure Drop: Maximum 2 psig at design flow when clean, and when dirty.

J. Pump Controls:
   1. Vary speed of motor to satisfy humidistat.
   2. High-pressure solenoid valve for each control zone shown on Drawings.
   3. Building automation system interface for each control zone for start/stop and status indication and control at central workstation.

K. Dispersion Fan:
   1. Aluminum blade propeller fan with finger guard and single-speed motor interlocked to operate with humidifier.
   2. Fan Mounting: Above and behind manifold on bracket integral to wall-mounting manifold.
L. Accessories:

1. Humidistat: Wall or Return-duct-mounting, solid-state, electronic-sensor controller capable of full-modulation or cycling control.
2. Duct-mounting, high-limit humidistat.
3. Airflow switch for preventing humidifier operation without airflow.

M. Capacities and Characteristics:

1. Humidification Rate: <Insert lb/h.
2. Dry-Bulb Air Temperature at Discharge: <Insert deg F.
3. Wet-Bulb Air Temperature at Discharge: <Insert deg F.
4. Number of Nozzles: <Insert number.>
5. Nozzle Spacing: <Insert inches.
6. Maximum Absorption Distance: <Insert inches.
8. Water Pump:
   a. Discharge Pressure: 1000 psig.

9. Dispersion Fan:
   a. Airflow: <Insert cfm.

    a. Volts: <Insert value.>
    b. Phase: <Insert value.>
    c. Hertz: <Insert value.>
    d. Full-Load Amperes: <Insert value.>
    e. Minimum Circuit Ampacity: <Insert value.>
    f. Maximum Overcurrent Protection: <Insert amperage.>

2.2 COMPRESSED-AIR ATOMIZING HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carel USA, LLC.
2. Hermidifier.

B. Nozzles: ASTM A 666, Type 316 stainless steel.

C. Manifold: ASTM A 269, Type 316 stainless-steel piping.

D. Droplet Filter: Biocide-treated polyethylene with maximum 0.30-inch wg resistance.

E. Piping and Fittings: ASTM A 269, Type 316 stainless-steel pipe and fittings.

F. Compressed-Air and Water Piping and Fittings: ASTM B 88, Type L copper pipe and wrought-copper fittings with soldered joints.

G. Final Water-Filter Efficiency: Minimum 98 percent retention of suspended particles 10 microns and larger from makeup water.

H. Final Water-Filter Pressure Drop: Maximum 2 psig at design flow when clean and when dirty.

I. Air and Water Solenoid Controls:
   1. Cycle valves to satisfy humidistat.
   2. Solenoid valves for each control zone shown on Drawings.
   3. Building automation system interface for each control zone for start/stop and status indication and control at central workstation.

J. Dispersion Fan:
   1. Aluminum blade propeller fan with finger guard and single-speed motor interlocked to operate with humidifier.
   2. Fan Mounting: Above and behind manifold on bracket integral to wall-mounting manifold.

K. Accessories:
   1. Humidistat: Wall or Return-duct-mounting, solid-state, electronic-sensor controller capable of full-modulation or cycling control.
   2. Duct-mounting, high-limit humidistat.
   3. Airflow switch for preventing humidifier operation without airflow.

L. Capacities and Characteristics:
1. Humidification Rate: <Insert lb/h.>
2. Dry-Bulb Air Temperature at Discharge: <Insert deg F.>
3. Wet-Bulb Air Temperature at Discharge: <Insert deg F.>
4. Number of Nozzles: <Insert number.>
5. Nozzle Spacing: <Insert inches.>
6. Maximum Absorption Distance: <Insert inches.>
8. Compressed Air:
   a. Airflow: <Insert cfm.>
   b. Pressure: <Insert psig.>
9. Dispersion Fan:
   a. Airflow: <Insert
    a. Volts: <Insert value.>
    b. Phase: <Insert value.>
    c. Hertz: <Insert value.>
    d. Full-Load Amperes: <Insert value.>
    e. Minimum Circuit Ampacity: <Insert value.>
    f. Maximum Overcurrent Protection: <Insert amperage.>

2.3 STEAM-INJECTION HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. DRI-STEEM Humidifier Company.
   3. Nortec Industries Inc.

B. Manifold: ASTM A 666, Type 304 stainless steel steam jacketed; insulated with 1/2-inch fiberglass and stainless-steel jacket; and extending the full width of duct or plenum with mounting brackets at ends.
C. Steam Separator: ASTM A 666, Type 304 stainless steel with separate humidifier control valve.

D. Humidifier Control Valve:
   1. Actuator: Electric modulating with spring return.

E. Steam Trap: Inverted-bucket type, sized for a minimum of 3 times the maximum rated condensate flow of humidifier at 1/2-psig inlet pressure.

F. Accessories:
   1. Return-duct-mounting humidistat.
   2. Duct-mounting, high-limit humidistat.
   3. Aquastat mounted on steam condensate return piping to prevent cold operation of humidifier.
   4. In-line strainer.
   5. Airflow switch for preventing humidifier operation without airflow.

G. Capacities and Characteristics:
   1. Humidification Rate: <Insert lb/h.>
   2. Steam Supply Pressure: <Insert psig.>
   3. Dry-Bulb Air Temperature at Discharge: <Insert deg F.>
   4. Wet-Bulb Air Temperature at Discharge: <Insert deg F.>
   5. Maximum Absorption Distance: <Insert inches.>
   6. Number of Manifolds: <Insert number.>
   7. Dispersion Fan:
      a. Airflow: <Insert cfm.>
      a. Volts: <Insert value.>
      b. Phase: <Insert value.>
      c. Hertz: <Insert value.>
      d. Full-Load Amperes: <Insert value.>
      e. Minimum Circuit Ampacity: <Insert value.>
      f. Maximum Overcurrent Protection: <Insert amperage.>
2.4 SELF-CONTAINED HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Nortec Industries Inc.


OR

C. Electrode Cylinder: Replaceable plastic assembly with disposable ionic bed inserts. Comply with UL 499.

OR

D. Gas-Fired Steam Generator: Factory assembled and tested.

1. Standard: Fabricate and label steam generator to comply with CSA.
2. Maximum Steam Pressure: 10 inches wg.
3. Burner Type: Natural-gas fired with modulating, low NOx infrared burner, minimum 82 percent efficient.
5. Ignition: Hot-surface ignition with flame safety system.

E. Manifold: ASTM A 666, Type 304 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.

F. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.

G. Control Panel:

1. Factory-wired disconnect switch.
2. Liquid-crystal display.
3. Programmable keyboard.
4. Set-point adjustment.
5. Warning signal indicating end of replaceable cylinder or ionic bed insert life.
7. Diagnostic, maintenance, alarm, and status features.
8. High-water sensor to prevent overfilling.

H. Controls:
1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
3. Field-adjustable timer to control drain cycle for flush duration and interval.
4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
5. Conductivity type level controls.

I. Accessories:
1. Humidistat: Wall or Return-duct-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
2. Duct-mounting, high-limit humidistat.
3. Airflow switch for preventing humidifier operation without airflow.

J. Capacities and Characteristics:
1. Humidification Rate: <Insert lb/h.>
2. Dry-Bulb Air Temperature at Discharge: <Insert deg F.>
3. Wet-Bulb Air Temperature at Discharge: <Insert deg F.>
4. Number of Manifolds: <Insert number.>
5. Maximum Absorption Distance: <Insert inches.
7. Electric-Resistance Heater Container or Electrode Cylinder:
   a. Power Input per Container or Cylinder: <Insert kilowatts.>
   b. Number of Containers or Cylinders: <Insert number.>

or

8. Gas-Fired Generator:
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

2.5 HEATED-PAN HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. DRI-STEEM Humidifier Company.
3. Nortec Industries Inc.

B. Heat Source: Hot water or Steam or Electric resistance.
Retain paragraph below for electric-resistance heat source.

C. Comply with UL 499.

Ionic bed inserts are a proprietary product of Armstrong.

D. Pan and Heat-Exchange Piping: ASTM A 666, Type 316 stainless steel with corrosion-resistant coating, overflow, and drain fittings. Include disposable ionic bed inserts.

E. Manifold: ASTM A 666, Type 316 stainless-steel, duct-mounting, single- or manifold-grid connected to heated-pan housing with flexible hose and extending across width of duct or plenum. Manifold shall have mounting brackets at both ends.

F. Controls:

1. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
2. Field-adjustable timer to control drain cycle for flush duration and interval.
3. Conductivity type level controls.
Retain paragraph below for steam heated-pan humidifier.

G. Piping Specialties: Inlet strainer, control valve, and steam trap.
Retain first paragraph below for hot-water, heated-pan humidifier.

H. Piping Specialties: Inlet strainer and control valve.

I. Accessories:
1. Humidistat: Wall or Return-duct-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
2. Duct-mounting, high-limit humidistat.
3. Airflow switch for preventing humidifier operation without airflow.

J. Capacities and Characteristics:
1. Humidification Rate: <Insert lb/h.
2. Dry-Bulb Air Temperature at Pan or Discharge: <Insert deg F.
3. Wet-Bulb Air Temperature at Pan or Discharge: <Insert deg F.
5. Pan Width: <Insert inches.
6. Number of Manifolds: <Insert number.>
7. Maximum Absorption Distance: <Insert inches.
9. Hot Water:
   b. Pressure Loss Including Control Valve: <Insert feet.
   c. Entering Temperature: <Insert deg F.
   d. Leaving Temperature: <Insert deg F.

10. Steam:
    a. Supply Pressure at Control Valve Inlet: <Insert psig.
    b. Condensing Rate: <Insert lb/h.

11. Electric-Resistance Heater Container or Electrode Cylinder:
    b. Number of Steps: <Insert number.>
   a. Volts: <Insert value.>
   b. Phase: <Insert value.>
   c. Hertz: <Insert value.>
   d. Full-Load Amperes: <Insert value.>
   e. Minimum Circuit Ampacity: <Insert value.>
   f. Maximum Overcurrent Protection: <Insert amperage.>

2.6 HEAT-EXCHANGER HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Nortec Industries Inc.

B. Fabricate and label steam generator to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. Heat Exchanger: ASTM A 666, Type 316 stainless steel with corrosion-resistant coating, overflow, and drain fittings. Include disposable ionic bed inserts.

D. Manifold: ASTM A 666, Type stainless-steel steam-jacketed, duct-mounting, single- or manifold-grid connected to steam generator with flexible hose and extending across width of duct or plenum. Manifold shall have mounting brackets for both ends. Insulate with 1/2-inch fiberglass and stainless-steel jacket extending full width of duct or plenum with mounting brackets at ends.

E. Controls:
   1. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
   2. Field-adjustable timer to control drain cycle for flush duration and interval.
   3. Conductivity type level controls.

F. Accessories:
   1. Humidistat: Wall or Return-duct-mounting, solid-state, electronic-sensor controller capable of full modulation.
2. Duct-mounting, high-limit humidistat.
3. Airflow switch for preventing humidifier operation without airflow.

G. Capacities and Characteristics:
1. Humidification Rate: <Insert lb/h.
2. Dry-Bulb Air Temperature at Discharge: <Insert deg F.
3. Wet-Bulb Air Temperature at Discharge: <Insert.
5. Number of Manifolds: <Insert number.>
6. Maximum Absorption Distance: <Insert inches.
8. Steam:
   a. Supply Pressure at Control Valve Inlet: <Insert psig.
   b. Condensing Rate: <Insert lb/h.

END OF SECTION 238413
DEHUMIDIFIERS
SECTION 238416 - DEHUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes factory-assembled and -tested, desiccant refrigeration-type dehumidification units with the following operation and optional accessories and components:
   1. Gas-furnace Hot-water-coil Steam-coil Electric post heater.
   2. Cooling package consisting of compressors remote condenser coil, and evaporator coil.
   3. Outside- and return-air dampers.
   4. Smoke detectors or firestats.
   6. Automatic controls and remote-control panel.
   8. Auxiliary boiler.

1.2 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of dehumidification units and are based on the specific system indicated

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and equipment mounting frame.

C. Manufacturer Seismic Qualification Certification: Submit certification that dehumidification units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Source quality-control test reports.

E. Startup report.

F. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.

G. Warranties: Special warranties specified in this Section.

H. LEED Submittals:
   1. Credit EA 4: Manufacturers' product data for refrigerants, including printed statement that refrigerants are free of HCFCs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 DESICCANT DEHUMIDIFICATION UNITS

A. Description: Factory-assembled and -tested, desiccant dehumidification unit suitable for outdoor installation.

B. Casing: Double wall construction with corrosion-protective coating and exterior powder-coated finish, removable panels with neoprene gaskets, minimum 2-inch-thick, glass-fiber insulation fill with no metal structure through the insulation, stainless-steel fasteners, knockouts for electrical and piping connections through the side of the unit within the roof curb, condensate drain connection, and lifting lugs.

C. Desiccant Rotor: Synthesized silica gel, enhanced with titanium, bonded to a ceramic matrix, and filling voids and encapsulating the ceramic. Driver shall be a motor with adjustable drive sheaves and belt-tensioning idler pulley or adjustable motor mount.

D. Direct-Fired, Natural Gas, Reactivation-Air Heater: Factory assembled, piped, and wired; complying with ANSI Z83.9 and NFPA 54, "National Fuel Gas Code"; and shall be AGA or ETL certified.
   1. Capacity Control: Fully modulated from 10 to 100 percent input at constant flow.
   2. Purge-period timer shall delay burner ignition and bypass low-limit control.
   4. Pilot: Electrically ignited by spark rod through high-voltage-ignition transformer with flame safety.
   6. Manual-Reset, Low- and High-Limit Controls: Maintain supply-air temperature between set points, and shut fan down if temperatures are exceeded.

E. Indirect-Fired, Power Vented, Natural Gas, Reactivation-Air Heater: Factory assembled, piped, and wired; complying with ANSI Z83.9 and NFPA 54, "National Fuel Gas Code"; and shall be AGA or ETL certified.
2. Capacity Control: Motorized valve fully modulating from 10 to 100 percent input.
6. Manual-Reset, Low- and High-Limit Controls: Maintain supply-air temperature between set points, and shut fan down if temperatures are exceeded.

F. Steam-Coil Reactivation-Air Heater: Distribution header coil fabricated according to ARI 410, with threaded steam supply and condensate connections.

1. Tubes: Copper.
2. Fins: Aluminum with fin spacing 0.125 inch
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Cast iron with drain and air vent tappings.
5. Frames: Galvanized-steel channel, 0.052 inch.
6. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
7. Source Quality Control: Factory test to 200 psig.

G. Hot-Water-Coil Reactivation-Air Heater: Continuous circuit coil fabricated according to ARI 410.

1. Tubes: Copper.
2. Fins: Aluminum with fin spacing 0.125 inch
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Cast iron with drain and air vent tappings.
5. Frames: Galvanized-steel channel, 0.052 inch.
6. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
7. Source Quality Control: Factory test to 300 psig.


1. Heating Element: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
2. Over-temperature Protection: Disk-type, automatic-reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from unit.
3. Thermal Cutouts: Load carrying, manual reset or replaceable, and factory wired in series with each heater stage.

I. Reactivation-Air Pretreatment Heat Exchanger: Sensible-only wheel that shall be cleanable with compressed air, vacuuming, low-temperature steam, or hot water without affecting latent heat recovery. Casing shall be equipped with adjustable noncontact seals to limit cross contamination to a maximum of 0.2 percent. Wheel shall be supported on grease-lubricated ball bearings with grease fittings extended to a serviceable location inside the dehumidification unit casing. Wheel shall be driven by a motor directly connected through a gear reducer or a belt drive.

J. Evaporative Cooler: Factory-assembled and -wired unit with intake grilles; bituminous-coated sump; and individually removable, spun wood-fiber pads with antirot salts to resist biological deterioration and provide absorbency 6-inch glass-fiber pads with UL 900 Class II saturants

1. Water Circulation System: Sump pump with strainer; water distribution troughs at top of cooler pads; float-operated, makeup water valve; and overflow and drain connections.
2. Automatic Drain System: Two-way, normally open drain valve; three-way, float-operated makeup water valve; and ambient thermostat.

K. Direct-Fired, Natural Gas Post Heater: Factory assembled, piped, and wired; complying with ANSI Z83.9 and NFPA 54, “National Fuel Gas Code”; and shall be AGA or ETL certified.

1. Capacity Control: Fully modulating from 10 to 100 percent input at constant flow.
2. Purge-period timer shall delay burner ignition and bypass low-limit control.
4. Pilot: Electrically ignited by spark rod through high-voltage-ignition transformer with flame safety.
6. Manual-Reset, Low- and High-Limit Controls: Maintain supply-air temperature between set points, and shut fan down if temperatures are exceeded.
I. Indirect-Fired, Power Vented, Natural Gas Post Heater: Factory assembled, piped, and wired; complying with ANSI Z83.9 and NFPA 54, "National Fuel Gas Code"; and shall be AGA or ETL certified.

2. Capacity Control: Motorized valve with two-position operation, fully modulating from 10 to 100 percent input.
6. Manual-Reset, Low- and High-Limit Controls: Maintain supply-air temperature between set points, and shut fan down if temperatures are exceeded.

M. Steam-Coil Post Heater: Distribution header coil fabricated according to ARI 410, with threaded steam supply and condensate connections.

1. Tubes: Copper.
2. Fins: Aluminum Copper with fin spacing 0.125 inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Cast iron with drain and air vent tappings.
5. Frames: Galvanized-steel channel, 0.052 inch.
6. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
   a. Working-Pressure Ratings: 100 psig, 400 deg F.
7. Source Quality Control: Test to 200 psig.

N. Hot-Water-Coil Post Heater: Continuous circuit coil fabricated according to ARI 410.

1. Tubes: Copper.
2. Fins: Aluminum Copper with fin spacing 0.125 inch.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Cast iron with drain and air vent tappings.
5. Frames: Galvanized-steel channel, 0.052 inch.
6. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
   a. Working-Pressure Ratings: 200 psig, 325 deg F.
7. Source Quality Control: Test to 300 psig.
   1. Heating Element: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
   2. Overtemperature Protection: Disk-type, automatic-reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from unit.
   3. Thermal Cutouts: Load carrying, manual reset or replaceable, and factory wired in series with each heater stage.

P. Supply and Exhaust Fans: Backward inclined, centrifugal, galvanized steel with baked-enamel powder-coated finish, belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing.

Q. Reactivation-Air Fan: Backward inclined, centrifugal, galvanized steel with baked-enamel powder-coated finish, belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the casing.

R. Supply- and Exhaust-Air Filters: 2-inch-thick, throwaway filters in filter rack, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.

S. Reactivation-Air Filters: 2-inch-thick, throwaway filters in filter rack, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.

   1. Refrigerant Coils: Copper tubes with mechanically bonded aluminum fins; factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits, seamless-copper headers with brazed connections, and galvanized stainless-steel frame. Coil and fins shall have a polyester coating. Coils shall have a minimum 300-psig working-pressure rating and be factory tested to 450 psig and to 300 psig while underwater.
   2. Compressors: scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.
a. Number of Refrigerant Circuits: Two for compressor capacities more than 7-1/2 tons.

b. Refrigerant Charge: R-134a R-407C R-410A Capacity Control:

1) Cylinder unloaders with steps as scheduled for reciprocating compressors.
2) Hot-gas bypass valve and piping on one compressor.
3) Cycle compressor.

c. Low-Pressure Cutout: Manual reset after three auto-reset failures.
d. High-Pressure Cutout: Manual reset.
f. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.
g. Adjustable, Low-Ambient, Head Pressure Control: Designed to operate at temperatures as low as 0 deg F by cycling condenser fans and controlling speed of last fan of each circuit.
h. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.

3. Condenser Fans: Propeller-type fans directly driven by motors with permanently lubricated bearings and internal thermal-overload protection.

U. Drain Pan: Stainless steel, pitched to comply with ASHRAE 62 or a minimum of 1-1/2 inches to drain connection.

V. Outside-Air Intake Dampers: Return- and outside-air intake dampers with damper operator and control package.

1. Leakage: Maximum leakage 1.0 percent at nominal airflow of 400 cfm per ton with 1-inch wg pressure differential.
2. Damper Operator 24-V ac, close coupled, with spring return.

W. Remote-control panel shall contain controls and indicator lights as follows:

1. On-off fan switch.
2. Minimum outside-air damper potentiometer position LCD.
4. Mechanical cooling malfunction indicator light.
5. Clogged filter indicator light.

X. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.
1. Operating Voltage: 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjusting after actuation to restore them to normal operation.
4. Integral Visual-Indicating Light: LED type. To indicate detector operation.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the fire alarm control panel.
7. Sensor: LED or infrared light source with matching silicon-cell receiver.
8. Detector Sensitivity: Between 2.5 and 3.5 percent/foot of smoke obscuration when tested according to UL 268A.

Y. Electrical Convenience Outlet: 115-V ac fused, duplex straight-blade receptacles separately fused and located inside dehumidification unit casing.

Z. Operating Controls: Factory-installed microprocessor shall control and monitor unit and communicate to central-control processor, and shall operate dehumidification units and maintain humidity and temperature set points.

1. Duct-mounted or Return-air humidity and room thermostat.
2. Control Outputs: Heating, cooling, and dehumidification.
3. Carbon Dioxide Sensor: Mount in return air to operate minimum outside-air damper position.
4. Discharge-air-, outdoor-air-, conditioned-space-, and control set-point-temperature LCD.
5. Outdoor enthalpy LCD.
6. Filter pressure drop LCD.
7. Status: Airflow, fans, system, unit operation, and operating mode.
8. Alarm LCD.
9. Magnehelic gage to indicate the pressure differential across process cooler and reactivation-air filters.
10. Drive motor to vary rotational speed in response to humidistat.
11. Monitor constant and variable motor loads.
12. Monitor variable frequency drive operation.
15. Monitor air distribution static pressure and ventilation air volumes.
2.3 REFRIGERATION DEHUMIDIFICATION UNITS

A. Description: Factory assembled and tested, complying with ASHRAE 15, "Safety Code for Mechanical Refrigeration," and designed for roof or slab installation.

1. Available Manufacturers:
   a. Century Refrigeration; Division of RAE Corporation.
   b. DECTRON Inc.
   c. Desert Aire.
   d. Heat Recovery Technology, Inc. (a.k.a., Pool Pak Inc).
   e. Nesbitt; a Mestek Company.

B. Casing: Double-wall construction with corrosion-protective coating and exterior powder-coated finish, removable panels with neoprene gaskets, minimum 2-inch-thick, glass-fiber insulation fill with no metal structure through the insulation, stainless-steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.

C. Supply and Exhaust Fans: Backward inclined, centrifugal, galvanized steel powder-coated finish, belt driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings with extended grease fittings easily accessible inside the dehumidification unit casing.

D. Filters: 2-inch thick, throwaway filters in filter rack, with a minimum efficiency report value of 6 according to ASHRAE 52.2 and 90 percent average arrestance according to ASHRAE 52.1.

E. Refrigerant Coils: Copper tubes with mechanically bonded aluminum fins; factory fabricated and tested to comply with ASHRAE 33 and ARI 410; with multiple refrigerant circuits, seamless-copper headers with brazed connections, and stainless steel frame. Coils shall have a polyester coating. Coils shall have a minimum 300-psig working-pressure rating and be factory tested to 450 psig and to 300 psig while underwater.

F. Compressors: scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.

   1. Number of Refrigerant Circuits: Two for compressor capacities more than 7-1/2 tons.
   2. Refrigerant Charge: R-134a or R-407C or R-410A.
   3. Capacity Control:
      a. Cylinder unloaders with steps as scheduled for reciprocating compressors.
b. Hot-gas bypass valve and piping on one compressor.
c. Cycle compressor.

4. Low-Pressure Cutout: Manual reset after three auto-reset failures.
7. Anti-recycling Timing Device: Prevent compressor restart for five minutes after shutdown.
8. Adjustable, Low-Ambient, Head-Pressure Control: Designed to operate at temperatures as low as 0 deg F by cycling condenser fans and controlling speed of last fan of each circuit.
9. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.

G. Drain Pan: Stainless steel, pitched to comply with ASHRAE 62 or a minimum of 1-1/2 inches to drain connection.

H. Condenser and Condenser Fans: Galvanized-steel condenser casing complying with ASTM A 653/A 653M, and having G90 coating designation; with coils having copper tubes mechanically expanded into aluminum fins with polyester coating. Propeller-type fans shall be directly driven by motors with permanently lubricated bearings.

I. Water-Cooling Heat Exchanger: Coaxial, vented, double-wall construction; with three-way refrigerant control valve.


K. Outside-Air Intake Dampers: Return- and outside-air intake dampers with damper operator and control package.
   1. Leakage: Maximum leakage 1.0 percent at nominal airflow of 400 cfm per ton with 1-inch wg pressure differential.
   2. Damper Operator: 24-V ac, close coupled, with gear train sealed in oil and with spring return.

L. Remote-control panel shall contain controls and indicator lights as follows:
   1. On-off fan switch.
   2. Minimum outside-air damper potentiometer position LCD.
   4. Mechanical cooling malfunction indicator light.
5. Clogged filter indicator light.

M. Smoke Detectors: Photoelectric detector located in return-air plenum, to de-energize unit.

1. Operating Voltage: 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjusting after actuation to restore them to normal operation.
4. Integral Visual-Indicating Light: LED type. To indicate detector operation.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the fire alarm control panel.
7. Sensor: LED or infrared light source with matching silicon-cell receiver.
8. Detector Sensitivity: Between 2.5 and 3.5 percent/foot of smoke obscuration when tested according to UL 268A.

N. Electrical Convenience Outlet: 115-V ac fused, duplex straight-blade receptacles separately fused and located inside dehumidification unit casing or in roof-curb perimeter.

O. Operating Controls: Factory-installed microprocessor shall control and monitor unit and communicate to central-control processor.

1. Control Outputs: Heating, cooling, and dehumidification.
2. Discharge-air-, outdoor-air-, conditioned-space-, and control set-point-temperature LCD.
3. Outdoor enthalpy LCD.
4. Filter pressure drop LCD.
5. Status: Airflow, fans, system, unit operation, and operating mode.
6. Alarm LCD.
7. Monitor constant and variable motor loads.
8. Monitor variable frequency drive operation.
11. Monitor air distribution static pressure and ventilation air volumes.
2.4 ROOF CURBS

A. Manufacturer’s standard, insulated with corrosion-protective coating, casketing, and factory-installed wood nailer, according to NRCA standards.

   1. Curb Height: Minimum 16 inches.
   2. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs and vertical and horizontal restraints; with Elastomeric waterproof membrane. Minimum 2-inch static deflection.

2.5 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.6 SOURCE QUALITY CONTROL

A. Verification of Performance: According to ASHRAE 139 and ARI 910.

   B. Sound-Power-Level Ratings: According to ARI 575.

END OF SECTION 238416
3. Electrical
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SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for raceways and cables.
   2. Sleeve seals.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves:  ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves:  Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings:  Galvanized sheet steel.

   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description:  Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Basis-of-Design Product: Subject to compliance with requirements, comparable product by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
   e. Link-Seal

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Include two for each sealing element.

4. Connecting Bolts and Nuts: of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

END OF SECTION 260500
MEDIUM VOLTAGE CABLES
SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.2 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NFPA 70.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

B. Test and inspect cables according to ICEA S-97-682 or ICEA S-94-649 before shipping.

C. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.

D. Remove and replace malfunctioning units and retest as specified above.

E. Submit the following Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
   1. Samples: 16-inch lengths of each type of cable indicated.
   2. Material Certificates: For each cable and accessory type, signed by manufacturers.
   3. Source quality-control test reports.
   4. Field quality-control test reports.

F. Conductor Wrap

   1. Description: Where two or more feeders are running through common pull/junction box, Arc-Proof wrapping shall be applied around each feeder.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Cables:
      b. General Cable Technologies Corporation.
      c. Kerite Co. (The); Hubbell Incorporated.
      d. Okonite Company (The).
      e. Pirelli Cables & Systems NA.
f. Rome Cable Corporation.
g. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

a. Engineered Products Company.
c. MPHusky.
d. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
e. RTE Components; Cooper Power Systems, Inc.
f. Scott Fetzer Co. (The); Adalet.
g. Thomas & Betts Corporation.
h. Thomas & Betts Corporation/Elastimold.
i. 3M; Electrical Products Division.

2.2 CABLES

A. Cable Type: MV90, MV105.

B. Comply with UL 1072, AEIC CS.

C. Conductor: Copper.

D. Conductor Stranding: Concentric lay, Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Crosslinked polyethylene.

G. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: As indicated on drawings.
2. Insulation Thickness: 100 or 133 percent insulation level.

H. Shielding: Solid copper wires, helically applied over semiconducting insulation shield.

I. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

J. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.
1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

K. Cable Armor: Interlocked aluminum or interlocked galvanized steel applied over cable.

L. Cable Jacket: Sunlight-resistant PVC.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.4 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase- and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.

2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.

4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

6. Class 3 Terminations: Kit with stress cone and compression-type connector.

C. Nonshielded Cable Terminations: Kit with compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer’s standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.

F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.

2.7 FAULT INDICATORS

A. Indicators: Manually reset fault indicator, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.
B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.
LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform the following field tests and inspections and prepare test reports:
1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding critical equipment and services for compliance with requirements.


3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

   a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

   b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

   c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test Reports: Prepare a written report to record the following:

   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

D. Submit the following Product Data:

   1. Qualification Data: For testing agency.
   2. Field quality-control test reports.

E. CONDUCTOR WRAP

   1. Description: Where two or more feeders are running through common pull/junction box, Arc-Proof wrapping shall be applied around each feeder 100 ampere and above.

F. All branch circuits shall be run with dedicated neutral conductors. Shared neutrals and multi-pole (common trip) circuit breakers for independent loads shall not be permitted.
G. Isolation Power systems (example Operating Rooms) branch circuits shall utilize type XHHN conductor insulation. THHN/THWN shall not be permitted for this application.

H. All boiler plant wiring for branch circuits and controls shall be high temperature rated.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. General Cable Corporation.
   5. Tyco Electronics Corp.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Type-THW, THHN-THWN, XHHW complying with NEMA WC 70.

D. Multiconductor Cable: Type-MC complying with UL 83, 1569, and 1063, hospital grade metal-clad cable with lightweight green aluminum interlocked armor, insulated ground wire, and redundant bare aluminum grounding/bonding conductor in direct contact with armor.

E. Fire-Rated Cable: Type-MI complying with UL 2196/ULC S139, mineral insulated copper sheathed, 2hour fire resistive wiring cable, Pyrotenax System 1850 with all required components and accessories to suit installation.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.
5. Link Seal

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Include two for each sealing element.
3. Connecting Bolts and Nuts: of length required to secure pressure plates to sealing elements. Include one for each sealing element.

END OF SECTION 260519
CONTROL VOLTAGE ELECTRICAL POWER CABLES
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. UTP cabling.
   2. Multimode optical fiber cabling.
   3. RS-232 cabling.
   4. RS-485 cabling.
   5. Low-voltage control cabling.
   7. Identification products.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.4 FACILITY OPERATIONS REQUIREMENTS

A. Perform the following field tests and inspections and prepare test reports:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

   b. Link End-to-End Attenuation Tests:

      1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.

      2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Submit the following Product Data: For cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
5. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
6. Source quality-control reports.
7. Field quality-control reports.
8. Maintenance Data: For wire and cable to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 5e and Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

a. Cable Management Solutions, Inc.
b. Cablofil Inc.
c. Cooper B-Line, Inc.
d. Cope - Tyco/Allied Tube & Conduit.
e. GS Metals Corp.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.

a. Basket Cable Trays: 6 inches wide and 2 inches deep or as indicated on drawings. Wire mesh spacing shall not exceed 2 by 4 inches.
b. Trough or Ventilated Cable Trays: Nominally 6 inches.
c. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches.
d. Channel Cable Trays: One-piece construction, nominally 4 inches wide. Slot spacing shall not exceed 4-1/2 inches o.c.
e. Solid-Bottom or Nonventilated Cable Trays: One-piece construction, nominally 12 inches wide.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry."

2.3 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Draka USA.
5. Genesis Cable Products; Honeywell International, Inc.
6. KRONE Incorporated.
7. Mohawk; a division of Belden CDT.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Superior Essex Inc.
10. SYSTIMAX Solutions; a CommScope, Inc. brand.
11. 3M.
12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, four-pair UTP.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e or Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications, General Purpose: Type CM or Type CMG.
   b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
   c. Communications, Riser Rated: Type CMR; complying with UL 1666.
   d. Communications, Limited Purpose: Type CMX.
   e. Multipurpose: Type MP or Type MPG.
   f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
   g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.4 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Dynacom Corporation.
3. Hubbell Premise Wiring.
4. KRONE Incorporated.
5. Leviton Voice & Data Division.
6. Molex Premise Networks; a division of Molex, Inc.
7. Nordex/CDT; a subsidiary of Cable Design Technologies.
8. Panduit Corp.
10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110 style for Category 5e and Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare; integral with connector bodies, including plugs and jacks where indicated.

2.5 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Corning Cable Systems.
4. General Cable Technologies Corporation.
5. Mohawk; a division of Belden CDT.
6. Nordex/CDT; a subsidiary of Cable Design Technologies.
7. Optical Connectivity Solutions Division; Emerson Network Power.
8. Superior Essex Inc.
9. SYSTIMAX Solutions; a CommScope, Inc. brand.
10. 3M.
11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 50/125 or 62.5/125-micrometer, fiber, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

   a. General Purpose, Nonconductive: Type OFN or OFNG.
   b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
   d. General Purpose, Conductive: Type OFC or Type OFCG.
   e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
   f. Riser Rated, Conductive: Type OFCR; complying with UL 1666.
5. Conductive cable shall be steel-armored type.
6. Maximum Attenuation: 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ADC.
   3. Berk-Tek; a Nexans company.
   4. Corning Cable Systems.
   5. Dynacom Corporation.
   6. Hubbell Premise Wiring.
   7. Molex Premise Networks; a division of Molex, Inc.
   8. Nordex/CDT; a subsidiary of Cable Design Technologies.
   9. Optical Connectivity Solutions Division; Emerson Network Power.
   10. Siemon Co. (The).

   1. Quick-connect, simplex and duplex connectors. Insertion loss not more than 0.75 dB.
   2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 RS-232 CABLE

A. Standard Cable: NFPA 70, Type CM.
1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

2.8 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CM or Type CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
2.9 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

C. Paired Cable: NFPA 70, Type CMG.
   1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.

2.10 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, Type XHHN, in raceway, complying with UL 83 and UL 44.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN or Type XHHN, in raceway or power-limited tray cable, in cable tray, complying with UL 83 or UL 44.
C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.11 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

END OF SECTION 260523
GROUNDING & BONDING FOR ELECTRICAL SYSTEMS
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency’s field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems <Insert locations> based on NETA MTS NFPA 70B <Insert reference>.

   a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

   b. Include recommended testing intervals.
1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

D. Comply with UL 467 for grounding and bonding materials and equipment.

1.4 FACILITY OPERATIONS REQUIREMENTS

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

B. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their
depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Submit the following Product Data: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.
6. Field quality-control test reports.
7. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
   a. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, grounding connections for separately derived systems.
      1) Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      2) Include recommended testing intervals

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

3. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn copper.
2. Conductor Protector: Half-round PVC
D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches or as indicated on drawings in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Use for bonding to steel and as indicated.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by10 feet in diameter.

   1. Backfill Material: Electrode manufacturer’s recommended material.

END OF SECTION 260526
HANGERS & SUPPORTS FOR ELECTRICAL SYSTEMS
SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Submit the following Product Data for steel slotted support systems:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Equipment supports.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
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1. Manufacturers: Subject to compliance with requirements, provide products by one of
the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to
   MFMA-4.
3. Nonmetallic Coatings: Manufacturer’s standard PVC, polyurethane, or polyester
   coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer’s standard painted coating applied according to
   MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings,
designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of
   threaded body and insulating wedging plug or plugs for non-armored electrical conductors or
   cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping
   pieces as required to suit individual conductors or cables supported. Body shall be
   malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates,
   shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or
   their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement
      concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for
      supported loads and building materials where used.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section “Metal Fabrications” for steel shapes and plates.

END OF SECTION 260529
RACEWAY & BOXES FOR ELECTRICAL SYSTEMS
SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS
A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
      a. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

B. Submit the following Product Data:
   1. Custom enclosures and cabinets.
   2. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
3. Manufacturer Seismic Qualification Certification.
4. Qualification Data: For professional engineer and testing agency.
5. Source quality-control test reports.

C. Conductor Wrap:
   1. Description: Where two or more feeders are running through common pull/junction box, Arc-Proof wrapping shall be applied around each feeder 100 ampere and above.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   7. Maverick Tube Corporation.

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit:
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

F. EMT: ANSI C80.3.
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G. FMC: Zinc-coated steel or aluminum.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   2. Fittings for EMT: Steel set-screw fitting. Unicouple connector assembly is acceptable. Compression-type fittings on a per design basis with FO approval.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.
   4. CANTEX Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT/Cole-Flex.
   11. RACO; a Hubbell Company.
   12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, unless otherwise indicated.
D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Arnco Corporation.
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for this type of installation.

2.4 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers As indicated.

E. Finish: Manufacturer's standard enamel finish.
2.5 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hoffman.
   2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Thomas & Betts Corporation.
      c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Butler Manufacturing Company; Walker Division.
      b. Enduro Systems, Inc.; Composite Products Division.
      c. Hubbell Incorporated; Wiring Device-Kellems Division.
      d. Lamson & Sessions; Carlon Electrical Products.
      e. Panduit Corp.
2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
7. RACO; a Hubbell Company.
10. Spring City Electrical Manufacturing Company.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum or galvanized, cast iron with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation.
   d. NewBasis.
C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. Christy Concrete Products.
      d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carson Industries LLC.
      b. Christy Concrete Products.
      c. Nordic Fiberglass, Inc.

2.9 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.10 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
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3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM, NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel, Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Length required to secure pressure plates to sealing elements. Include one for each sealing element.

END OF SECTION 260533
CABLE TRAYS FOR ELECTRICAL SYSTEMS
1.1 SUMMAR Y

A. This Section includes cable trays and accessories.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.

2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.

3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.

4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

C. Submit the following Product Data:
   1. Shop Drawings: For each type of cable tray.
      a. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
      b. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   3. Field quality-control reports.
   4. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Cooper B-Line, Inc.
2.2 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.

1. Factory-standard primer, ready for field painting; with cadmium-plated hardware according to ASTM B 766.
2. Mill galvanized before fabrication, complying with ASTM A 653/A 653M, G90 coating; with hardware galvanized according to ASTM B 633.
3. Electrogalvanized before fabrication, complying with ASTM B 633; with hardware galvanized according to ASTM B 633.
5. PVC coating applied in a fluidized bed or by electrostatic spray; with chromium-zinc, ASTM F 1136 hardware.
6. Epoxy-resin paint over paint manufacturer’s recommended primer and corrosion-inhibiting treatment; with cadmium-plated hardware according to ASTM B 766.

B. Cable Trays, Fittings, and Accessories: Aluminum, complying with NEMA VE 1, Aluminum Association’s Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with chromium-zinc, ASTM F 1136 splice-plate fasteners, bolts, and screws

C. Cable Trays, Fittings, and Accessories: Stainless steel, complying with NEMA VE 1.

D. Cable Trays, Fittings, and Accessories: Fiberglass, complying with NEMA FG 1 and UL 568. Splice-plate fasteners, bolts, and screws shall be fiberglass-encapsulated stainless steel. Design fasteners so that no metal is visible when fully assembled and tightened. Fastener encapsulation shall not be damaged when torqued to manufacturer’s recommended value.

E. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

1. Center-hanger supports may be used only when specifically indicated.
2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Covers: of same materials and finishes as cable tray.

C. Barrier Strips: Same materials and finishes as cable tray.

D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Materials and fastening are specified in Division 26 Section "Identification for Electrical Systems."

END OF SECTION 260536
VIBRATION & SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Spring isolators.
   3. Restrained spring isolators.
   4. Channel support systems.
   5. Restraint cables.
   6. Hanger rod stiffeners.
   7. Anchorage bushings and washers.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
E. Comply with NFPA 70. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform the following tests and inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

D. Submit the following Product Data:

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
   b. Annotate to indicate application of each product submitted and compliance with requirements.
2. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
3. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including...
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

analysis data signed and sealed by the qualified professional engineer responsible for
their preparation.

a. Design Calculations: Calculate static and dynamic loading due to equipment
   weight and operation, seismic forces required to select vibration isolators and
   seismic restraints.

b. Indicate materials and dimensions and identify hardware, including attachment
   and anchorage devices.

c. Field-fabricated supports.

d. Seismic-Restraint Details.

E. Coordination Drawings: Show coordination of seismic bracing for electrical components
   with other systems and equipment in the vicinity, including other supports and seismic
   restraints.

F. Welding certificates.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the
   following:

   1. Ace Mountings Co., Inc.
   2. Amber/Booth Company, Inc.
   4. Isolation Technology, Inc.
   7. Vibration Eliminator Co., Inc.
   8. Vibration Isolation.

B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad
   area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes
   that match requirements of supported equipment.

   1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.
B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
IDENTIFICATION FOR ELECTRICAL SYSTEMS
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
4. Warning labels and signs.
5. Instruction signs.
7. Miscellaneous identification products.

1.2 QUALITY ASSURANCE


C. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Equipment to Be Labeled: All equipment requires a label 94D shall include but not limited to:

   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchgear and switchboards.
   d. Transformers.
   e. Electrical substations.
   f. Emergency system boxes and enclosures.
   g. Motor-control centers.
   h. Disconnect switches.
i. Enclosed circuit breakers.
j. Motor starters.
k. Push-button stations.
l. Power transfer equipment.
m. Contactors.
n. Remote-controlled switches, dimmer modules, and control devices.
o. Battery inverter units.
p. Battery racks.
q. Power-generating units.
r. Voice and data cable terminal equipment.
s. Master clock and program equipment.
t. Intercommunication and call system master and staff stations.
u. Television/audio components, racks, and controls.
v. Fire-alarm control panel and annunciators.
w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
x. Monitoring and control equipment.
y. Uninterruptible power supply equipment.
z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
aa. Automatic Transfer Equipment Power Distribution Units.
bb. Receptacles and lighting switches.

B. Submit the following Product Data:
   1. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
   2. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:

   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.
C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 inches wide by 4 mils thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS


B. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

C. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
Identification for Electrical Systems

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS


2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
   1. Exterior Ferrous Metal:
      a. Semigloss Alkyd-Enamel Finish: finish coat over a primer.
         1) Primer: Exterior ferrous-metal primer.
         2) Finish Coats: Exterior semigloss alkyd enamel.
   2. Exterior Zinc-Coated Metal (except Raceways):
      a. Semigloss Alkyd-Enamel Finish: finish coat over a primer.
         1) Primer: Exterior zinc-coated metal primer.
         2) Finish Coats: Exterior semigloss alkyd enamel.
   3. Interior Ferrous Metal:
      a. Semigloss Acrylic-Enamel Finish: finish coat over a primer.
         1) Primer: Interior ferrous-metal primer.
         2) Finish Coats: Interior semigloss acrylic enamel.
4. Interior Zinc-Coated Metal (except Raceways):
   
a. Semigloss Acrylic-Enamel Finish: finish coat over a primer.
   
   1) Primer: Interior zinc-coated metal primer.
   
   2) Finish Coats: Interior semigloss acrylic enamel.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

END OF SECTION 260553
SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.2 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

B. Submit the following Product Data:
   1. Computer software program to be used for studies.
   2. For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
   3. Coordination-study input data, including completed computer program input data sheets.
   4. Study and Equipment Evaluation Reports.
   5. Coordination-Study Report.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   1. CGI CYME.
   2. EDSA Micro Corporation.
   3. ESA Inc.
   4. Operation Technology, Inc.
   5. SKM Systems Analysis, Inc.
A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
   a. Arcing faults.
   b. Simultaneous faults.
   c. Explicit negative sequence.
   d. Mutual coupling in zero sequence.

END OF SECTION 260573
SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following for monitoring and control of electrical power system:
   1. PC-based workstation(s) and software.
   2. Communication network and interface modules for data transmission protocols.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing power monitoring and control equipment similar to that indicated for this Project and with a record of successful in-service performance.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Tests and Inspections:
   1. Electrical Tests: Use caution when testing devices containing solid-state components.
   2. Continuity tests of circuits.
   3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command.
and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
b. Test LANs according to requirements in Division 27 Section "Communications Horizontal Cabling."
c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
d. Verify accuracy of graphic screens and icons.
e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

B. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

C. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

D. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

E. Remove and replace malfunctioning devices and circuits and retest as specified above.

F. Submit the following Product Data:

1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

5. Software and Firmware Operational Documentation.

6. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Provide product by one of the following:

1. Allen-Bradley; Rockwell Automation.
2. Cutler-Hammer Group; Eaton Electrical Inc.
3. GE Industrial Systems.
4. Siemens Building Technologies
5. Schneider Electric.

2.2 FUNCTIONAL DESCRIPTION

A. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.

1. Calculate and Record the Following:
   
   a. Load factor.
   b. Peak demand periods.
   c. Consumption correlated with facility activities.

2. Measure and Record Metering Data for the Following:

   a. Electricity.
   b. Domestic water.
   c. Natural gas.

B. Software: Calculate allocation of utility costs.

1. Automatically Import Energy Usage Records to Allocate Energy Costs for the Following:

   a. At least 30 departments.
   b. At least five processes.
   c. At least five buildings.
2. Verify utility bills.

C. Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:

1. Voltage regulation and unbalance.
2. Continuous three-phase rms voltage.
3. Periodic max./min./avg. samples.
4. Harmonics.
5. Voltage excursions.

D. Emergency Load Shedding: Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:

1. Determine system topology.
2. Evaluate remaining loads and sources.
3. Shed loads in less than 100 ms.

E. Demand Management:

1. Peaking or co-generator control.
2. Load interlocking.
3. Load shedding.
4. Load trimming.

F. System: Report equipment status and power system control.

2.3 SYSTEM REQUIREMENTS

A. Monitoring and Control System: Include PC-based workstation, with its operating system and application software, connected to data transmission network.

B. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.
C. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

2.4 OPERATING SYSTEM

A. Software: Configured to run on a portable laptop computer, a single PC, or a PDA, with capability for accessing a single meter at a time. System is not connected to a LAN. Modbus TCP/IP, RS-232, and RS-485 digital communications.


D. Software: Configured for a server and multiple client PCs, each with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be Web enabled. Workstations and portable computers shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP RS-232, and RS-485 digital communications.

E. Operating System Software: Based on Microsoft Windows workstation operating system. Software shall have the following features:

1. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
2. Graphical user interface to show pull-down menus and a menu tree format.
3. Capability for future additions within the indicated system size limits.

F. Peer Computer Control Software: Shall detect a failure of workstation and shall cause other workstation to assume control of all system functions without interruption of operation. Drivers shall be provided in both central computers to support this mode of operation.

2.5 APPLICATIONS SOFTWARE

A. Basic Requirements:

1. Fully compatible with and based on the approved operating system.
2. Password-protected operator login and access; three levels, minimum.
5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
6. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
7. Automatic and encrypted backups for database and history; automatically stored at central control PC and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
8. Operator audit trail for recording and reporting all changes made to user-defined system options.

B. Workstation Server Functions:

1. Support other client PCs on the LAN.
2. Maintain recorded data in databases accessible from other PCs on the LAN.

C. Data Formats:

1. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
2. Option to convert reports and graphics to HTML format.
3. Interactive graphics.
4. Option to send preprogrammed or operator designed e-mail reports.

D. Metered Data: Display metered values in real time.

E. Remote Control:

1. Display circuit-breaker status and allow breaker control.
2. User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of metered demands, utility contracted load shedding, or combinations of these.

F. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.

G. Graphics: Interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:
Electrical Power Monitoring and Control

H. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:

1. Operator log on/off.
2. Attempted operator log on/off.
3. All alarms.
4. Equipment operation counters.
5. Out-of-limit, pickup, trip, and no-response events.

I. Trending Reports: Display data acquired in real-time from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.

1. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
2. Charting, statistical, and display functions of standard Windows-based spreadsheet.

J. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.

1. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.

K. Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event; include the graphic displays of the following, based on user-specified criteria:

1. Phase voltages, phase currents, and residual current.
2. Overlay of three-phase currents, and overlay each phase voltage and current.
3. Waveforms ranging in length from 2 cycles to 5 minutes.
4. Disturbance and steady-state waveforms up to 512 points per cycle.
5. Transient waveforms up to 83,333 points per cycle on 60-Hz base.
6. Calculated waveform on a minimum of four cycles of data of the following:
   a. THD.
   b. rms magnitudes.
   c. Peak values.
   d. Crest factors.
e. Magnitude of individual harmonics.

M. Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.
   1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
   2. Sort and report by device name and by function.
   3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
   4. Differentiate alarm signals from other indications.
   5. When system is reset, report reset event with same information concerning device, location, date, and time.

2.6 COMMUNICATION COMPONENTS AND NETWORKS


B. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

2.7 POWER MONITORS

A. Separately mounted, permanently installed instrument for power monitoring and control.
   1. Enclosure: NEMA 250, Type 1.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

C. rms Real-Time Measurements:
1. Current: Each phase, neutral, average of three phases, percent unbalance.
2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
3. Power: Per phase and three-phase total.
4. Reactive Power: Per phase and three-phase total.
5. Apparent Power: Per phase and three-phase total.
6. Power Factor: Per phase and three-phase total.
7. Displacement Power Factor: Per phase and three-phase total.
8. Frequency.
9. THD: Current and voltage.
10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
11. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
12. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Peak.

E. Demand Real Power Calculations, Three-Phase Total:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Predicted.
   5. Peak.
   6. Coincident with peak kVA demand.
   7. Coincident with kVAR demand.

F. Demand Reactive Power Calculations, Three-Phase Total:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Predicted.
   5. Peak.
   6. Coincident with peak kVA demand.
   7. Coincident with kVAR demand.

G. Demand Apparent Power Calculations, Three-Phase Total:
Electrical Power Monitoring and Control

H. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:

1. Last completed interval.
2. Coincident with kW peak.
3. Coincident with kVAR peak.
4. Coincident with kVA peak.

I. Power Analysis Values:

1. THD, Voltage and Current: Per phase, three phase, and neutral.
2. Displacement Power Factor: Per phase, three phase.
3. Fundamental Voltage, Magnitude and Angle: Per phase.
5. Fundamental Real Power: Per phase, three phase.
8. Phase rotation.
10. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st harmonic.

J. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
   a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
   b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:
   a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
   b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
   c. Demand can be synchronized with clock in the power meter.

K. Sampling:
   1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
   2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.

L. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
   1. Line-to-line voltage.
   2. Line-to-neutral voltage.
   3. Current per phase.
   4. Line-to-line voltage unbalance.
   5. Line-to-neutral voltage unbalance.
   6. Power factor.
   7. Displacement power factor.
   8. Total power.
   9. Total reactive power.
   10. Total apparent power.
   11. THD voltage L-L.
   12. THD voltage L-N.
   13. THD current.

M. Harmonic Calculation: Display and record the following:
   1. Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. Calculate for all three phases, current and voltage, and residual current.
Current and voltage information for all phases shall be obtained simultaneously from same cycle.

2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.

N. Current and Voltage Ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

O. Accuracy:

1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
2. Accuracy from Light to Full Rating:
   a. Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
   b. Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
   c. Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
   d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

P. Waveform Capture:

1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

Q. Input: One digital input signal(s).

1. Normal mode for on/off signal.
2. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
3. Conditional energy signal to control conditional energy accumulation.

R. Outputs:
1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
2. Closed in either a momentary or latched mode as defined by user.
3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
5. One relay output module(s), providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
6. Output Relay Control:
   a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
   b. Normally open and normally closed contacts, field configured to operate as follows:
      1) Normal contact closure where contacts change state for as long as signal exists.
      2) Latched mode when contacts change state on receipt of a pickup signal; changed state is held until a dropout signal is received.
      3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
      4) End of power demand interval when relay operates as synchronization pulse for other devices.
      5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
      6) Output controlled by multiple alarms using Boolean-type logic.

S. Onboard Data Logging:
1. Store logged data, alarms, events, and waveforms in 800 KB of onboard nonvolatile memory.
2. Stored Data:
   a. Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 to 52 days of 15-minute interval data, depending on number of quantities selected.
   b. Custom Data Logs: user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
      1) Schedule interval.
2) Event definition.
3) Configured as "fill-and-hold" or "circular, first-in first-out."

c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

T. Alarms.

1. User Options:
   a. Define pickup, dropout, and delay.
   b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
   c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.

2. Alarm Events:
   a. Over/undercurrent.
   b. Over/undervoltage.
   c. Current imbalance.
   d. Phase loss, current.
   e. Phase loss, voltage.
   f. Voltage imbalance.
   g. Over kW demand.
   h. Phase reversal.
   i. Digital input off/on.
   j. End of incremental energy interval.
   k. End of demand interval.

U. Control Power: 90- to 457-V ac or 100- to 300-V dc.

V. Communications:

1. Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet or RS-485 Modbus TCP/IP. Coordinate with hospital’s IT.
2. Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.
W. Display Monitor:

1. Backlighted LCD to display metered data with touch-screen selecting device.
2. Touch-screen display shall be a minimum 21-inch diagonal, resolution of 128 by 1024 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
3. Display four values on one screen at same time.
   a. Current, per phase rms, three-phase average and neutral.
   b. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
   c. Real power, per phase and three-phase total.
   d. Reactive power, per phase and three-phase total.
   e. Apparent power, per phase and three-phase total.
   f. Power factor, per phase and three-phase total.
   g. Frequency.
   h. Demand current, per phase and three-phase average.
   i. Demand real power, three-phase total.
   j. Demand apparent power, three-phase total.
   k. Accumulated energy (MWh and MVARh).
   l. THD, current and voltage, per phase.

4. Reset: Allow reset of the following parameters at the display:
   a. Peak demand current.
   b. Peak demand power (kW) and peak demand apparent power (kVA).
   c. Energy (MWh) and reactive energy (MVARh).

2.8 STANDALONE, WEB-ENABLED MONITORING AND CONTROL INSTRUMENT

A. Separately mounted, permanently installed instrument for power monitoring and control.

1. Enclosure: NEMA 250, Type 1.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.

1. Indoor installation in nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
C. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.

D. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.

E. Server Configuration:
   1. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
   2. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
   3. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
   4. Operating Software: Suitable for local access; firewall protected.

F. Data Access:
   1. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.

G. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.

H. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:
   1. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor, and breaker status.
   2. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
   3. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
   4. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
   5. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
   6. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.
   7. Motor-Control Center Status Page: Circuit name, three-phase average rms current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
8. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.
   
a. Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
   
b. Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user selectable. Time interval to be displayed on scale shall be for previous day or week.

9. Export historical energy data to a PC or workstation through network using FTP (File Transfer Protocol). Format exported data in a CSV (Comma Separated Variable) file format for importing into spreadsheet applications.

I. Communications:

1. Power monitor: Permanently connected to communicate via RS-485 Modbus TCP/IP or Modbus TCP via an 100 Base-T Ethernet. Coordinate with Hospital’s IT.
2. Local Plug-in Connections: RS-232 and 100 Base-T Ethernet.

2.9 WORKSTATION HARDWARE

A. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

B. Computer: Standard unmodified PC of modular design.

1. Memory: 1024 <Insert number> MB of usable installed memory, expandable to a minimum of 4096 <Insert number> MB without additional chassis or power supplies.

2. Real-Time Clock:

   a. Accuracy: Plus or minus 1 minute per month.
   
   b. Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.
   
   c. Clock shall function for one year without power.
d. Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.

3. Serial Ports: Two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.

4. Parallel Port: Enhanced.

5. Two USB Ports

6. LAN Adapter Card: 100-Mbps PCI bus, internal network interface card.

7. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.

8. Color Monitor: PC compatible, not less than 21 inches, LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm.


10. Mouse: Standard, compatible with installed software.

11. Disk Storage: Include the following, each with appropriate controller:

   a. Minimum 500-GB hard disk, maximum average access time of 10 ms.


13. DVD-ROM Drive:


15. Interface: Bidirectional parallel and universal serial bus.

C. Redundant Central Computer: Connected in a hot standby, peer configuration; automatically maintains copies of system software, application software, and data files. System transactions and other activities that alter system data files shall be updated to system files of redundant computer in near real-time. If central computer fails, redundant computer shall assume control immediately and automatically.
LIGHTING CONTROL DEVICES
SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

C. Submit the following Product Data:
1. Show installation details for occupancy and light-level sensors.
2. Field quality-control test reports.
3. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Intermatic, Inc.
   3. Lithonia Lighting; Acuity Lighting Group, Inc.
   4. Lightolier Controls; a Genlyte Company.
   5. Square D; Schneider Electric.
   6. TORK.

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Intermatic, Inc.
   2. Lithonia Lighting; Acuity Lighting Group, Inc.
   3. Novitas, Inc.
   4. Square D; Schneider Electric.
   5. TORK.

B. Description: Solid state, with dry contacts, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 INDOOR PHOTOELECTRIC SWITCHES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
2. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. Paragon Electric Co.; Invensys Climate Controls.
6. Square D; Schneider Electric.
7. TORK.
8. Touch-Plate, Inc.
9. Watt Stopper (The).

C. Ceiling or Skylight Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.4 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. Sensor Switch, Inc.
6. TORK.
7. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.5 OUTDOOR MOTION SENSORS (PIR)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bryant Electric; a Hubbell Company.
2. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
5. TORK.
6. Watt Stopper (The).

B. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as raintight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

C. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..

D. Detection Coverage: Up to 35 feet, with a field of view of 90 degrees.

E. Lighting Fixture Mounted Sensor: Suitable for switching 300 W of tungsten load at 120- or 277-V ac.

F. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

1. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

2.6 LIGHTING CONTACTORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
4. GE Industrial Systems; Total Lighting Control.
5. Hubbell Lighting.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Square D; Schneider Electric.
8. TORK.
9. Watt Stopper (The).
D. Description: Electrically operated and mechanically held, combination type, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.7 LIGHTING CONTROL RELAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide ASCO 918 with accessories or a comparable product by one of the following:
   1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
   2. Eaton Electrical Inc.; Cutler-Hammer Products.
   3. GE Industrial Systems; Total Lighting Control.
   4. Square D; Schneider Electric.

C. Description: Electrically operated and mechanically held.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.8 EMERGENCY SHUNT RELAY

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Lighting Control and Design, Inc.

D. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual switching contacts; complying with UL 924.

1. Coil Rating: As indicated on the drawings.

2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 260923
SECONDARY UNIT SUBSTATIONS
SECTION 261116 - SECONDARY UNIT SUBSTATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes indoor and outdoor secondary unit substations, each consisting of the following:
   1. Primary incoming section.
   2. Transformer.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2.

F. Comply with IEEE C37.121.
G. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

H. Prepare, submit and obtain approval for all related work and other filings to the NYC Advisory Board as defined in the New York City Electrical Code and Chapter 34-Electrical Code Rules of Title 1 of the Rules of the City of New York.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:

1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
2. Ratios on the rated voltage connection and on tap extreme connections.
3. Polarity and phase relation on the rated voltage connection.
4. No-load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
8. Induced potential.
9. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class FA rating.
   a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
5. Remove and replace malfunctioning units and retest as specified above.

C. Perform the following follow-up service:

Secondary Unit Substations

261116 - 3
1. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
   a. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
   b. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
      c. Adjust transformer taps.
      d. Rebalance loads.
      e. Prepare written request for voltage adjustment by electric utility.
      f. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
      g. Report: Prepare a written report covering monitoring performed and corrective action taken.

2. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

D. Submit the following Product Data:

2. Dimensioned plans and elevations showing major components and features.
3. One-line diagram.
4. List of materials.
5. Nameplate legends.
6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
7. Short-time and short-circuit current ratings of secondary unit substations and components.
8. Ratings of individual protective devices.
10. Primary Fuses: Submit recommendations and size calculations.
11. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
12. Manufacturer Seismic Qualification Certification.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Olsun Electrical Corporation.

2.2 MANUFACTURED UNITS

A. Indoor Unit Arrangement: Single assembly.

B. Indoor Unit Arrangement: Separate secondary distribution equipment connected with busway.

C. Outdoor Unit Arrangement: Single assembly.
   1. Weatherproof, listed for installation outdoors, complying with IEEE C37.20.1.

D. Enclosure Finish: Factory-applied finish in manufacturer’s standard color, including under surfaces treated with corrosion-resistant undercoating.

E. Enclosure Finish: Factory-applied finish in manufacturer’s standard gray over a rust-inhibiting primer on treated metal surface.

2.3 INCOMING SECTION

A. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters.

B. Primary Incoming Section: Transformer cover-mounted bushings.

C. Primary Incoming Section: Enclosed, air-interrupter, primary switch.
1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame, complying with IEEE C37.20.3.
2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
3. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
4. Window: Permits viewing switch-blade positions when door is closed.
5. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
6. Continuous-Current Rating: 600 A.
7. Short-Circuit Rating:
   a. Short-time momentary asymmetrical fault rating of 40 kA.
   b. 3-second symmetrical rating of 25-kA RMS.
   c. Fault close asymmetrical rating of 40 kA.
8. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
   a. Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
   b. Indicator integral with each fuse to show when it has blown.
   c. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.
D. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.4 LIQUID-FILLED TRANSFORMER SECTION
A. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding, secondary unit substation transformer.
B. Insulating Liquid: Mineral oil complying with ASTM D 3487, Type II, and tested according to ASTM D 117.
C. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

D. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

E. Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.

F. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12-percent kVA output, at 65 deg C temperature rise, without decreasing rated transformer life.

G. Insulation Temperature Rise: 65 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.

H. Basic Impulse Level: Comply with UL 1062.

I. Basic Impulse Level: As indicated on drawings.

J. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

K. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

L. Cooling System: Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.

M. Sound level may not exceed 58 dB, without fans.

N. Impedance: As indicated on drawings.

O. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
1. Liquid-level gage.
2. Pressure-vacuum gage.
3. Liquid temperature indicator.
4. Drain and filter valves.
5. Pressure relief device.

2.5  DRY-TYPE TRANSFORMER SECTION

A. Description: IEEE C57.12.01, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.

B. Enclosure as indicated, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.

C. Cooling System: complying with IEEE C57.12.01.
   1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
   2. Include mounting provision for fans.

D. Insulation Materials: IEEE C57.12.01, rated 220 deg C.

E. Insulation Temperature Rise: 115 deg C, maximum rise above 40 deg C.

F. Basic Impulse Level: As indicated on drawings.

G. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

H. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps below rated primary voltage.

I. Impedance: As indicated.

J. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

2.6  SECONDARY DISTRIBUTION SECTION

A. Secondary Terminal Compartment: Bus.
B. Secondary Distribution: As indicated on drawings.

C. Network Protectors:

1. Rated for continuous service in an ambient temperature of up to 40 deg C, applied to 3-phase, 4-wire, solidly grounded wye secondary networks. Comply with IEEE C57.12.44.

2. Dead-front, drawout design with externally mounted fuses, using hand-cranked rail system. Relay and control panel located on a separate drawout module.

3. Protector Operator: Spring-close or stored-energy mechanism, rated to close on a 40,000 RMS symmetrical load.

4. Control Voltage: Not more than 125 V.

5. Control microprocessor-based, three-phase, tripping relay with features and functions as follows:
   a. Close protector if positive sequence power flows into the network. Adjustable closing range shall be from 0.5 to 3.5 V in phase difference between network and transformer voltages.
   b. Trip protector if there is a net, three-phase, reverse power flow through protector. Trip protectors shall be adjustable from 0.05 to 5 percent of continuous-current rating of current transformers within protector.
   c. Trip protector if there is a flow of reverse magnetizing current of its associated transformer.
   d. Field-adjustable relay parameters and watt or watt-var trip values.

6. Protector shall not open under any fault on network side of protector.

7. Current-limiting fuses shall have interrupting capacity of 150,000 A on network side of protector for protection against switchboard bus faults.

8. Mechanical interlocks shall prevent racking in and racking out when protector is closed.

9. Auxiliary contacts shall be remotely tripped and locked out by four-wire remote pilot devices.

10. Network protectors shall have not less than two spare auxiliary dry contacts.

11. Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted fuse truck, with Class L fuses rated for 200-kA interrupting capacity, and key interlocked with each associated protector.

12. Network Switchgear-Mounted Disconnect Switch: Supply each network-protector circuit with a switchgear-mounted main circuit breaker rated for fault current that can be delivered by the network transformers, less one. Use drawout type to provide a means of isolating the load side of each protector from the network bus.
2.7 IDENTIFICATION DEVICES

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section “Identification for Electrical Systems.”

2.8 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.

B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:

1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
2. Ratios on the rated voltage connection and on tap extreme connections.
3. Polarity and phase relation on the rated voltage connection.
4. No-load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
8. Induced potential.
9. Temperature Test: If a transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class FA rating.

   a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

10. Owner will witness all required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

END OF SECTION 261116
MEDIUM VOLTAGE TRANSFORMERS
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:

1. Liquid-filled distribution and power transformers.
2. Dry-type distribution and power transformers.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2.


F. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other
applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Factory Tests: Perform design and routine tests according to standards specified for components.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
4. No-load loss at rated voltage on rated-voltage connection.
5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
8. Induced potential.
9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
   a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

10. Owner will witness all required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

C. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation. Report results in writing.

D. Perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning units and retest as specified above.

F. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

G. Follow-up service: Voltage Monitoring and Adjusting: If requested by Owner, perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
   a. Adjust transformer taps.
   b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.


5. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

H. Submit the following Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

1. Shop Drawings: Diagram power wiring.
2. Coordination Drawings: Floor plans, drawn to scale.
3. Manufacturer Seismic Qualification Certification.
4. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Olsun Electrical Corporation.

2.2 LIQUID-FILLED DISTRIBUTION AND POWER TRANSFORMERS

A. Description: IEEE C57.12.00 and UL 1062, liquid-filled, 2-winding transformers.

B. Insulating Liquid: Less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.

C. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C. Insulation system shall be rated to continuously allow an additional 12 percent kilovolt-ampere output, at 65 deg C temperature rise, without decreasing rated transformer life.

D. Basic Impulse Level: Comply with UL 1062.

E. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
F. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps below rated primary voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

G. Cooling System: Class OA, self-cooled. Cooling systems shall include auxiliary cooling equipment, automatic controls, and status indicating lights.

H. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

I. Impedance: As indicated.

J. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap. Include the following additional accessories:
   1. Liquid-level gage.
   2. Pressure-vacuum gage.
   3. Liquid temperature indicator.
   4. Drain and filter valves.
   5. Pressure relief device.

2.3 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

A. Description: NEMA ST 20, IEEE C57.12.01, UL 1562 listed and labeled, dry-type, 2-winding transformers.
   1. Vacuum-pressure impregnated and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.

B. Primary Connection (if stand alone): Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.
C. Primary Connection (if part of switchgear): Transition terminal compartment with connection pattern to match switchgear.

D. Secondary Connection (if stand alone): Air terminal compartment with hinged door. Tin-plated copper bar for incoming line termination, predrilled to accept terminals for indicated conductors.

E. Secondary Connection (if part of switchgear): Transition terminal compartment with connection pattern to match switchgear.

F. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.

G. Insulation Temperature Rise: 115 deg C, maximum rise above 40 deg C.

H. Basic Impulse Level: As indicated.

I. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

   1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
   2. Include mounting provision for fans.

K. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

L. Impedance: As indicated.

M. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

END OF SECTION 261200
MEDIUM VOLTAGE SWITCHGEAR
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes switchgear with the following optional components, features, and accessories:
   1. Communication modules.
   2. Analog instruments.
   3. Relays.
   4. Surge arresters.
   6. Fungus proofing.
   7. Control battery system.
   8. Mimic bus.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

   1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. Comply with IEEE C2.

F. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

G. Prepare, submit and obtain approval for all related work and other filings to the NYC Advisory Board as defined in the New York City Electrical Code and Chapter 34-Electrical Code Rules of Title 1 of the Rules of the City of New York.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Before shipment of equipment, perform the following tests and prepare test reports:

1. Production tests on circuit breakers according to ANSI C37.09.
2. Production tests on completed switchgear assembly according to IEEE C37.20.2.

B. Assemble switchgear and equipment in manufacturer's plant and perform the following:

1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.
2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

C. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

D. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.
E. Manufacturer’s Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear, wiring, components, connections, and equipment installation
2. Assist in field testing of equipment.

F. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
   a. Switchgear.
   b. Circuit breakers.
   c. Protective relays.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.

G. Remove and replace malfunctioning units and retest as specified above.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
2. Instrument: Use an infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

I. Submit the following Product Data:

1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual interrupter switches and circuit breakers.
2. Time-current characteristic curves for overcurrent protective devices, including circuit-breaker relay trip devices and fusible devices.
3. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment.
5. Wiring Diagrams.
6. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where piping and ducts are prohibited.
7. Manufacturer Seismic Qualification Certification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1.
B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.
C. System Voltage: As indicated.

2.3 METAL-ENCLOSED INTERRUPTER SWITCHGEAR

A. Manufacturers:
   1. ABB Control, Inc.
   2. Eaton Corporation; Cutler-Hammer Products.
   5. Square D; Schneider Electric.
B. Comply with IEEE C37.20.3.

C. Comply with IEEE C37.20.7. Provide arc-resistant switchgear.


E. Ratings: Comply with standard ratings designated in IEEE C37.20.3 for maximum-rated voltage specified.
   1. Main-Bus Rating: As indicated.

F. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.
   1. Rating: As indicated, continuous duty and load break.
   2. Duty-Cycle, Fault Closing: 40,000 asymmetrical A.
   3. Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
   4. Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
   5. Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
   6. Protective Shields: Cover live components and terminals.
   7. Fuses: De-energized if switch is open.

G. Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.

H. Window: Permit viewing switchblade positions if door is closed.

I. Power Fuses: Comply with the following and with applicable requirements in NEMA SG 2:
   1. Indicator: Integral with each fuse to indicate when it has blown.
   2. Mounting: Positively held in position with provision for easy removal and replacement from front without special tools.
   3. Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube.
2.4 METAL-CLAD, CIRCUIT-BREAKER SWITCHGEAR

A. Manufacturers:
   1. ABB Control, Inc.
   2. Eaton Corporation; Cutler-Hammer Products.
   3. General Electric Distribution & Control.
   5. Square D; Schneider Electric.

B. Comply with IEEE C37.20.3.

C. Comply with IEEE C37.20.7. Provide arc-resistant switchgear.

D. Nominal Interrupting-Capacity Class: As indicated.

E. Ratings: Comply with IEEE C37.04.
   1. Main-Bus Rating: As indicated.

F. Circuit Breakers: Three-pole, single-throw, electrically operated, drawout-mounting units using three individual, vacuum-sealed interrupter modules and including the following features:
   1. Designed to operate at rated voltage to interrupt fault current within its rating within five cycles of trip initiation. For systems with X/R ratio of 17 or less, transient voltage during interruption shall not exceed twice the rated line-to-ground voltage of the system.
   2. Contact-Wear Indicator: Readily accessible to field maintenance personnel.
   3. Minimum of six Type A and six Type B spare contacts.
   4. Interchangeability: Circuit breakers are interchangeable with vacuum circuit breakers of same current and interrupting ratings.
   5. Internal sulfur hexafluoride pressure is not to exceed 2.5 bars during normal operation.

   b. Continuous Current Rating of Tie Circuit Breaker: 2000 A.
   c. Continuous Current Rating of Feeder Circuit Breaker: 1200 A.
6. Operating Mechanism: Electrically charged, mechanically and electrically trip-free, stored-energy operated:
   
a. Closing speed of moving contacts to be independent of both control and operator.
   
b. Design mechanism to permit manual charging and slow closing of contacts for inspection or adjustment.
   
   1) Control Power: 120-V ac for closing and tripping.
   
c. Provide shunt trip capability independent of overcurrent trip.

G. Test Accessories: Relay and meter test plugs.

H. Low-DC-Voltage Alarm: Switchgear shall have a monitor for dc control power voltage with a remote alarm located where indicated. Alarm shall sound if voltage falls to an adjustable value to indicate an impending battery failure. Factory set alarm value at 80 percent of full-charge voltage.

I. Grounding and Testing Device: Suitable for phasing out, testing, and grounding switchgear bus or feeder if device is installed in place of circuit breaker. Include the following:

   1. Portable Grounding and Testing Device: Interchangeable with drawout-mounting, medium-voltage circuit breakers to provide interlocked electrical access to either bus or feeder; electrically operated.
   
   2. System control cabinet permanently mounted near switchgear.
   
   3. Portable Remote-Control Station: For grounding and testing device.
   
   4. Control-Cabinet Coupler Cable: Of adequate length to connect device inserted in any switchgear cubicle and control cabinet.
   
   5. Remote-Control Coupler Cable: 50 feet long to connect control cabinet and portable remote-control station.
   
   6. Permanent Control Power Wiring: From control cabinet to power source.
   
   7. Protective Cover: Fabricated of heavy-duty plastic and fitted to device.
   
   8. Approval of Grounding and Testing Device System: Obtain approval of final system design from utility company and agency designated by Owner to handle future maintenance of medium-voltage switchgear.

J. Circuit-Breaker Test Cabinet: Separately mounted and containing push buttons for circuit-breaker closing and tripping, control relay, fuses, and secondary coupler with cable approximately 108 inches long. Include a set of secondary devices for operating circuit breaker if removed from switchgear and moved near test cabinet. Include provision for storage of test and maintenance accessories in cabinet.
K. Remote-Tripping Device: Wall-mounting emergency control station to open circuit breakers; located in red cast-metal box with break-glass operation.

2.5 FABRICATION

A. Indoor Enclosure: Steel.

B. Outdoor Enclosure: Galvanized steel, weatherproof construction; integral structural-steel base frame with factory-applied asphaltic undercoating.

1. Each compartment shall have the following features:
   a. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
   b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
   c. Louvers equipped with insect and rodent screen and filter, and arranged to permit air circulation while excluding rodents and exterior dust.
   d. Hinged front door with locking provisions.
   e. Interior light with switch.
   f. Weatherproof GFCI duplex receptacle.
   g. Power for heaters, lights, and receptacles to be provided as indicated.

2. Weatherproof internal aisle construction shall have the following features:
   a. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
   b. Aisle access doors at each end with exterior locking provisions and interior panic latches.
   c. Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.
   d. Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.
   e. GFCI duplex receptacles, a minimum of two, located in aisle.
   f. Aisle ventilation louvers equipped with insect and rodent screen and filter, and arranged to permit air circulation while excluding rodents and exterior dust.

C. Finish: Manufacturer's standard gray finish over rust-inhibiting primer on phosphatizing-treated metal surfaces.
D. Bus Transition Unit: Arranged to suit bus and adjacent units.
E. Incoming-Line Unit: Arranged to suit incoming line.
F. Outgoing Feeder Units: Arranged to suit distribution feeders.
G. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.
H. Key Interlocks: Arranged to effect interlocking schemes indicated.
I. Provisions for Future Key Interlocks: Mountings and hardware required for future installation of locks, where indicated.

2.6 COMPONENTS

A. Main Bus: Copper, silver plated at connection points; full length of switchgear.
B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches; full length of switchgear.
C. Bus Insulation: Covered with flame-retardant insulation.
   1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
   2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.
E. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems, listed and labeled by an NRTL, and with the following features:
   1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
   2. Switch-selectable digital display with the following features:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Three-Phase Real Power: Plus or minus 2 percent.
e. Three-Phase Reactive Power: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i. Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Division 26 Section "Electrical Power Monitoring and Control."

4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

F. Analog Instruments: Rectangular, 4-1/2 inches square, 1 percent accuracy, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment, and complying with ANSI C39.1.
   1. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
   2. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
   3. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
   4. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
   5. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
      a. Operation: Counts and records a succession of pulses entering two channels.
      b. Housing: Drawout, back-connected case arranged for semiflush mounting.

G. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.

   1. Install in cable termination compartments in each phase of circuit.
   2. Coordinate rating with circuit voltage.

I. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.
J. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.

K. Control Power Supply: DC battery system.

L. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
2. Conduits sized according to NFPA 70 for duty required.

2.7 CONTROL BATTERY SYSTEM

A. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded.

B. Battery: Lead-calcium type in sealed, clear plastic or glass containers, complete with electrolyte, fully charged and arranged for shipment with electrolyte in cells. Limit weight of each container to not more than 70 lb and cells per container to not more than 3. System batteries shall be suitable for service at an ambient temperature ranging from minus 18 to 25 deg C. Limit variation of current output to 0.8 percent for each degree below 25 deg C down to minus 8 deg C.

C. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. Accessories:

1. Thermometers with specific-gravity correction scales.
2. Hydrometer syringes.
3. Set of socket wrenches and other tools required for battery maintenance.
4. Wall-mounting, nonmetallic storage rack fitted to store above items.
5. Set of cell numerals.

D. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Other features of charger include the following:
1. DC ammeter.
2. DC Voltmeter: Maximum error of 5 percent at full-charge voltage; operates with toggle switch to select between battery and charger voltages.
3. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, with midpoint junction connected to ground by normally open push-button contact.
4. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
5. Charging-Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.
6. AC power supply is 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.
7. Protective Feature: Current-limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; to protect charger from damage due to overload, including short circuit on output terminals.
8. Electrical Filtering: Reduces charger’s audible noise to less than 26 dB.

END OF SECTION 261300
LOW VOLTAGE TRANSFORMERS
SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

B. Refer to specification section 262213 for Hazard Location Encapsulated Distribution Transformer. All NYPH transformers shall be epoxy-filled type meeting this standard.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C57.12.91, “Test Code for Dry-Type Distribution and Power Transformers.”.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

Low-Voltage Transformers

262200 - 2
FACILITY OPERATIONS REQUIREMENTS

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

D. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

F. Remove and replace units that do not pass tests or inspections and retest as specified above.

G. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
   1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
   3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

H. Submit the following Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
   1. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Manufacturer Seismic Qualification Certification.
   3. Dimensioned Outline Drawings of Equipment Unit.
   4. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
2.1 MANUFACTURERS
   
   A. Available Manufacturers:
   2. General Electric Company.
   3. Hammond Co.;
   4. Olsen Transformers
   5. Siemens Energy & Automation, Inc.
   6. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS
   
   A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
   
   B. Cores: Grain-oriented, non-aging silicon steel.
   
   C. Coils: Continuous windings without splices except for taps.
      1. Internal Coil Connections: Brazed or pressure type.
      2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS
   
   A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
   
   B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
   
   C. Cores: One leg per phase.
   
   D. Enclosure: Ventilated, NEMA 250, Type 2.
      1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
   
   E. Transformer Enclosure Finish: Comply with NEMA 250.
      1. Finish Color: ANSI 61 gray.
   
   F. Taps for Transformers Smaller Than 3 kVA: None.
G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

K. K-Factor Rating as indicated: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
   2. Indicate value of K-factor on transformer nameplate.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.
   3. Shield Effectiveness:
      a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
      b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
      c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

M. Wall Brackets: Manufacturer's standard brackets.

N. Fungus Proofing: Permanent fungicidal treatment for coil and core.

O. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
P. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40dBA
2. 30 to 50 kVA: 45dBA
3. 51 to 150 kVA: 50dBA
4. 151 to 300 kVA: 55dBA
5. 301 to 500 kVA: 60dBA
6. 501 to 750 kVA: 62dBA
7. 751 to 1000 kVA: 64dBA

END OF SECTION 262200
HAZARDOUS LOCATION ENCAPSULATED DISTRIBUTION TRANSFORMER
SECTION 262213 – HAZARDOUS LOCATION ENCAPSULATED DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section defines dry-type, encapsulated enclosed transformers as indicated.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InteRnational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

    i Testing Agency’s Field Supervisor: Person currently certified by the InteRnational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing.

    B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

    C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

    D. Comply with ANSI C57.12.01/NEMA ST 20 for Dry Type Transformer General Applications.


    G. Comply with UL certified (UL file number: E258346), CSA.

    H. Comply with UL1604 Class I, Division 2, Groups A, B, C & D Hazardous Locations.

    I. Comply with ABS Type Approval for Marine Duty Service and Offshore Applications.

    J. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 SUBMITALS

A. Submit shop drawing and product data for approval and final documentation in the quantities listed according to the Conditions of the contract.
Customer name. Customer location and customer order number shall identify all transmittals.

Product Data including KVA rating, Temperature Rise, Detailed enclosure dimensions, Primary & Secondary nominal voltages, primary voltage taps, no load & full load losses per NEMA ST20, impedances, unit weight, warranty.

1.4 STORAGE AND HANDLING

A. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions.

B. Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

1.5 WARRANTY

A. The transformer shall carry a 10 year limited warranty.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION:

A. All single phase and three phase transformers shall be encapsulated type. The primary side of each transformer shall, if applicable, be provided with taps that meet or exceed NEMA standards.

B. Transformers shall be designed, constructed and rated in accordance with UL, CSA, NEMA and ABS standards. If shipping to Europe, transformer will also have to be manufactured in accordance to CE standards and carry a CE mark.

2.2 VOLTAGE AND KVA REQUIREMENTS:

A. Primary Voltage: Three Phase – 208, 480 Volts

B. Secondary Voltage: Three Phase - 208Y/120, 480Y/277 Volts

C. kVA Rating: Single Phase – 0.05 through 37.5 kVA (standard sizes as specified)

D. System Frequency: 60 Hertz
2.3 BASIC REQUIREMENTS:

A. Standard impedance at 60Hz:
   2% to 5% (up to 10 kVA), 4% to 6.5% (above 10 kVA)
B. Name Plate Rating: Linear load, 60Hz
C. Single-phase or three-phase, common core construction. Convection air cooled.
D. Insulation Class: 180°C
E. Temperature Rise: 80°C
F. Taps: 2 x ± 2.5% (2FCAN, 2FCBN)
G. Core construction: high grade non-aging, fully processed silicon steel laminations or better.
H. Coil conductors: copper windings, with terminations brazed, welded or bolted.
I. Electrostatic Shielding on all single phase units over 0.50 kVA and all three phase units.
J. Impregnation: vacuum impregnated core & coils.
K. Inrush current: 10 times full load rating (max.).
L. Sound level to meet NEMA ST-20.
M. Enclosure: ventilated, NEMA 3R
N. Enclosure Finish: ANSI 61 Grey suitable for UL50 outdoor applications.
O. Transformers shall terminate in either leads or mounting pads. Mounting lugs will be included on all units up to and including 270 amp ratings. Contractors shall provide all necessary lugs not already provided with transformer.
P. UL listed, CSA approved.
Q. Silicon Brass (or approved equivalent) hardware.
R. UL Approved for Hazardous Locations UL 1604 (Class I, Division II, Groups A, B, C and D locations), (Temperature Classification equal to T3C
S. Type ABS Approval for Marine Duty Service and Offshore Applications – Electric Distribution and Propulsion.
T. Built to NEMA ST-20 and in accordance with all applicable UL, CSA and ANSI/IEEE standards.
U. Mounting:
   i. Encapsulated units up to 285 lbs: Suitable for wall or floor mounting (30, 45 kVA).
   ii. Encapsulated units over 285 lbs.: Suitable for floor mounting only (greater than 45 kVA).

OPTIONS:

- Type 316 Stainless Steel Enclosures
- Stainless Steel Nameplate
- Seismic: are designed and manufactured to comply with the specification, “IBC 2006; Section 1613; Earthquake Loads” with the site specific parameters of “Occupancy Cat-
Category III: Special Occupancy*: IP=1.25 and “Site Profile Type: SD= Stiff Soil” with the seismic forces defined as “Spectral Acceleration for Short Periods: SS= 1.0g”. (Applicable to floor mounted units only.)

2.4 ACCEPTABLE PRODUCT AND MANUFACTURER:

A. HPS TITAN transformer, Hammond Power Solutions Inc.
B. Substitutions are permitted, subject to meeting all requirements of this specification.

END OF SECTION 262213
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

F. Prepare, submit and obtain approval for all related work and other filings to the NYC Advisory Board as defined in the New York City Electrical Code and Chapter 34-Electrical Code Rules of Title 1 of the Rules of the City of New York.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear installation, including wiring, components, connections, and equipment.
2. Verify that electrical control wiring installation complies with manufacturer’s submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Complete installation and startup checks according to manufacturer's written instructions.
4. Assist in field testing of equipment.
5. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
   a. Switchgear.
   b. Circuit breakers.
   c. Protective relays.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.

2. Remove and replace malfunctioning units and retest as specified above.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Submit the following Product Data:
1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment.
2. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements.
3. Manufacturer Seismic Qualification Certification.
4. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. General Electric Company.
4. Square D; Schneider Electric.
5. Electrothech.

2.2 RATINGS

A. Nominal System Voltage: As indicated.

B. Main-Bus Continuous: As indicated.
C. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly.
2.3 FABRICATION

A. Factory assembled and tested and complying with IEEE C37.20.1.

B. Indoor Enclosure Material: Steel.

C. Outdoor Enclosure Material: Galvanized steel.

D. Outdoor Enclosure Fabrication Requirements: Weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating; and each compartment equipped with the following features:
   1. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
   2. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
   3. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
   4. Hinged front door with padlocking provisions.
   5. Interior light with switch.
   7. Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.
   8. Aisle access doors with outside padlocking provisions and interior panic latches.
   9. Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.
  10. Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.
  11. GFCI duplex receptacles, a minimum of two, located in aisle.
  12. Aisle ventilation louvers equipped with insect and rodent screen and filter and arranged to permit air circulation while excluding insects, rodents, and exterior dust.

E. Finish: IEEE C37.20.1, manufacturer’s standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

F. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.

G. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.

H. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.
I. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.

J. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:

1. Utility metering compartment that complies with utility company requirements.
2. Bus transition sections.
3. Incoming-line pull sections.
4. Hinged front panels for access to metering, accessory, and blank compartments.
5. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
   a. Set pull box back from front to clear circuit-breaker lifting mechanism.
   b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
   c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

K. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.

1. Main Phase Bus: Uniform capacity the entire length of assembly.
3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
5. Phase- and Neutral-Bus Material: Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
6. Use copper for connecting circuit-breaker line to copper bus.
7. Contact Surfaces of Buses: Silver plated.
9. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
10. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
11. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
12. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.

13. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.

   a. Sprayed Insulation Thickness: 3 mils, minimum.
   b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

2.4 COMPONENTS

   1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
   2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.

B. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
   2. Switch-selectable digital display of the following:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
      d. Three-Phase Real Power: Plus or minus 2 percent.
      e. Three-Phase Reactive Power: Plus or minus 2 percent.
      f. Power Factor: Plus or minus 2 percent.
      g. Frequency: Plus or minus 0.5 percent.
      h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
      i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
C. Analog Instruments: Rectangular, 4-1/2-inch square, accurate within 1 percent, semiflush mounting, with antiparallax 250-degree scale and external zero adjustment, complying with ANSI C39.1.

1. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
2. Voltmeter Selector Switch: Rotary type with off position to provide readings of phase-to-phase and phase-to-neutral voltages.
3. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
4. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
5. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
6. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
7. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.
   a. Operation: Meter counts and records a succession of pulses entering two channels.
   b. Housing: Drawout, back-connected case arranged for semiflush mounting.

D. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

   1. Install in cable termination compartments and connect in each phase of circuit.
   2. Coordinate rating with circuit voltage.

F. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

G. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.

H. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:
   1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
   a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
   b. Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.

4. Fuses are specified in Division 26 Section "Fuses."

I. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
2. Conductors sized according to NFPA 70 for duty required.

2.5 CIRCUIT BREAKERS

A. Description: Comply with IEEE C37.13.

B. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

1. Normal Closing Speed: Independent of both control and operator.
2. Slow Closing Speed: Optional with operator for inspection and adjustment.
4. Operation counter.

D. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:

1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
3. Field-adjustable, time-current characteristics.
4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.

5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."


7. Pickup Points: Five minimum, for instantaneous-trip functions.

8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
   a. Three-wire circuit or system.
   b. Four-wire circuit or system.
   c. Four-wire, double-ended substation.

9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.

E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type “a” and two Type “b” stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

F. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:

1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.

2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
   a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
   b. Disconnected Position: Primary and secondary devices and ground contact disengaged.
G. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

H. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

I. Operating Handle: One for each circuit breaker capable of manual operation.

J. Electric Close Button: One for each electrically operated circuit breaker.

K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

L. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.

M. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

N. Shunt-Trip Devices: Where indicated.

O. Fused Circuit Breakers: Circuit breaker and fuse combinations complying with requirements for circuit breakers and trip devices and with the following:

1. Fuses: NEMA FU 1, Class L current limiting, sized to coordinate with and protect associated circuit breaker.

2. Circuit Breakers with Frame Size 1600 A and Smaller: Fuses on line side of associated circuit breaker, on a common drawout mounting, arranged so fuses are accessible only when circuit breaker is in disconnected position.

3. Circuit Breakers with Frame Sizes More Than 1600 A: Fuses and circuit breakers may be installed in separate compartments on separate drawout mountings. Fuse drawout element is interlocked with associated power circuit breaker to prevent drawing out fuse element unless circuit breaker is in open position.

4. Open-Fuse Trip Device: Positive means of tripping and holding circuit breaker in open position when a fuse opens. Open-fuse status is indicated at front of circuit breaker or fuse drawout element.

P. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.
2.6 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
   1. Racking handle to manually move circuit breaker between connected and disconnected positions.
   2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.

B. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

C. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

D. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.7 IDENTIFICATION

A. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   2. Medium: Painted graphics, as selected by Architect.
   3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer’s full range.

B. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
   1. Frame size of each circuit breaker.
   2. Trip rating for each circuit breaker.
   3. Conduit and wire size for each feeder.
PARALLELING LOW VOLTAGE SWITCHGEAR
SECTION 262313 - PARALLELING LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes metal-clad, low voltage, circuit-breaker switchgear, and associated control systems, for paralleling generators on an isolated bus and for distributing power in ac systems.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

F. Prepare, submit and obtain approval for all related work and other filings to the NYC Advisory Board as defined in the New York City Electrical Code and Chapter 34-Electrical Code Rules of Title 1 of the Rules of the City of New York.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Source Quality Control:

1. Before shipment of equipment, perform the following tests and prepare test reports:
   a. Production tests on circuit breakers according to ANSI C37.09.
   b. Production tests on completed switchgear assembly according to IEEE C37.20.2.

2. Assemble switchgear and equipment in manufacturer's plant and perform the following:
   a. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current-transformer secondary circuits.
   b. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

3. Prepare equipment for shipment.
   a. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
   b. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

B. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Manufacturer’s Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect switchgear installation, including wiring, components, connections, and equipment.
2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Complete installation and startup checks according to manufacturer's written instructions.
4. Assist in field testing of equipment.
5. Report results in writing

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
   a. Switchgear.
   b. Circuit breakers.
   c. Protective relays.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.

2. Remove and replace malfunctioning units and retest as specified above.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Submit the following Product Data:

   1. Technical data on features, performance, electrical characteristics, ratings, and finishes.
   2. Rated capacities, operating characteristics, furnished specialties, and accessories for individual circuit breakers.
   3. Features, characteristics, ratings, factory settings, and time-current characteristic curves for individual relays and overcurrent protective devices.
   4. Description of sequence of operation for paralleling controls.
5. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment.
6. Wiring diagrams.
7. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements.
8. Manufacturer Seismic Qualification Certification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
1. Emerson; ASCO Power Technologies, LP.

B. Individual Generator Control and Monitoring Panel: Provide each generator with a control and monitoring panel that allows the operator to view status and control operation of respective generator. Provide panel with the following features and characteristics:

1. Generator Metering: 1 percent accuracy class or better.
   a. Ammeter, Voltmeter, Frequency Meter, Wattmeter, Kilowatt-Hour Meter, and Power Factor Meter:
      1) For three-phase and four-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.
      2) Provide analog devices for voltmeter and frequency meters.
      3) Provide switches or other provisions to allow reading of both generator and bus voltages and frequencies from this metering set.
   b. Synchroscope and "Generator Set Synchronized" Indication:
      1) Provide lamp or LED indication of synchronization.
      2) Provide 360-degree analog movement synchroscope.
   c. Engine run-time meter, start counter, rpm meter, and battery voltage meter.
   d. Engine oil temperature gage and engine coolant temperature gage.
2. Generator Protective and Control Switches: Provide oiltight, industrial-grade switches in generator control and monitoring panel.
   a. Mode Selector Switch (Run/Off/Auto):
      1) "Run" mode to start and accelerate unit to rated speed and voltage, but not close paralleling circuit breaker.
      2) "Off" mode to prevent generator from starting or to immediately shutdown generator if running.
      3) "Auto" mode to allow generator to start on receipt of remote start signal.
   b. Circuit-Breaker Trip/Close Switch: Interlocked with system control so that circuit-breaker closure is impossible unless the following occurs:
      1) Mode selector switch is in "Run" position.
      2) Generator set is synchronized with system bus.
   c. Control/reset push button with flashing lamp to indicate generator is locked out due to fault condition.
   d. Lamp test push button to simultaneously test all lamps on panel.
   e. Control Panel Illumination: DC lamps to illuminate panel when lighting from surrounding environment is not available.
   g. Voltage and Frequency Raise/Lower Switches:
      1) Allow plus/minus 5 percent adjustment when generator set is operating but not paralleled.

3. Generator Protective and Control Devices: Solid-state industrial relays, integrated microprocessor-based control devices, and other accessories and devices located either in generator control and monitoring panel or in switchgear control section to provide the following features and functions:
   a. Kilowatt Load Sharing Control:
      1) Operates engine governors during synchronizing and provides isochronous load sharing when paralleled.
      2) Allows generator set to ramp up to kilowatt load level signaled by system master controller.
   b. Load-Demand Governing Control:
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1) Causes generator set to ramp down to zero load when signaled to shut down in load-demand mode.
2) Causes generator set to ramp up to a proportional share of total bus load.

c. Kilovolt Ampere Rating Load Sharing Control:
   1) Operates alternator excitation system while generator set is paralleled.
   2) Causes sharing of reactive load among all generator sets to within 1 percent of equal levels without voltage drop.

d. Sync-Check and Paralleling Monitor and Control:
   1) Monitors and verifies that generator set has reached 90 percent of nominal voltage and frequency before closing to bus.
   2) Prevents out-of-phase paralleling if two or more generator sets reach operating conditions simultaneously, by sending "inhibit" signal to sets not designated by system as "first to close to bus."
   3) Recognizes failure of "first-to-close" generator set and signals system paralleling to continue.
   4) Prevents out-of-phase closure to bus due to errant manual or automatic operation of synchronizer.

e. Synchronizer Control:
   1) Adjusts engine governor to match voltage, frequency, and phase angle of paralleling bus.
   2) Maintains generator-set voltage within 1 percent of bus voltage, and phase angle within 20 electrical degrees of paralleling bus for 0.5 seconds before circuit-breaker closing.
   3) Provides "fail-to-synchronize time delay" adjustable from 10 to 120 seconds; with field selectivity to either initiate alarm or shut down generator set on failure condition.

f. Reverse Power Monitor and Control:
   1) Prevents sustained reverse power flow in generator set.
   2) Trips generator circuit breaker and initiates generator set shutdown when reverse power condition exceeds 10 percent of generator set kilowatt for three seconds.

g. Phase Rotation Monitor and Control:
1) Verifies generator set and paralleling bus phase rotation match prior to closing paralleling circuit breaker.

h. Electronic Alternator Overcurrent Alarm and Shutdown Control:
   1) Monitors current flow at generator-set output terminals.
   2) Initiates alarm when load current on generator set is more than 110 percent of rated current for more than 60 seconds.
   3) Provides overcurrent shutdown function matched to thermal damage curve of alternator. Provide without instantaneous-trip function.

i. Electronic Alternator Short-Circuit Protection:
   1) Provides shutdown when load current is more than 175 percent of rated current and combined time/current approaches thermal damage curve of alternator. Provide without instantaneous-trip function.

j. Loss of Excitation Monitor:
   1) Initiates alarm when sensing loss of excitation to alternator while paralleled to system bus.

k. Generator-Set Start Contacts: Redundant system, 10 A at 32-V dc.

l. Cool-Down Time-Delay Control: Adjustable, 0 to 600 seconds.
m. Start Time-Delay Control: Adjustable, 0 to 300 seconds.

n. Paralleling Circuit-Breaker Monitor and Control:
   1) Monitors circuit-breaker auxiliary contacts.
   2) Initiates fault signal if circuit breaker fails to close within adjustable time-delay period (0.5 to 15 seconds).
   3) Trips open and locks out paralleling circuit breaker upon paralleling circuit breaker failure to close, until manually reset.

4. Engine Protection and Local Annunciation:
   a. Provide annunciation and shutdown control modules for alarms indicated.
   b. Provide visual alarm status indicator and alarm horn with silence/acknowledge push button on generator control and monitoring panel.
   c. Annunciate the following conditions:
      1) Status, Light Only (Nonlatching):
         a) Generator engine control switch not in auto (red).
b) Generator engine control switch in auto (green).
c) Emergency mode (red).
d) Generator circuit breaker closed (red).
e) Generator circuit breaker open (green).
f) Engine stopped (green).
g) Engine running (red).
h) Engine cool-down (amber).

2) Pre-Alarm, Light and Horn (Nonlatching):
   a) Pre-high coolant temperature (amber).
   b) Pre-low oil pressure (amber).
   c) Low coolant temperature (amber).
   d) Engine low battery (amber).
   e) Engine low fuel (amber).
   f) Generator fails to synchronize (amber).

3) Shutdown Alarm, Light and Horn (Latching):
   a) Engine overcrank (red).
   b) Engine overspeed (red).
   c) Engine low oil pressure (red).
   d) Engine high coolant temperature (red).
   e) Engine low coolant level (red).
   f) Engine remote emergency shutdown (red).
   g) Generator circuit breaker tripped (red).
   h) Generator loss of field (red).
   i) Generator reverse power (red).
   j) Generator undervoltage (red).
   k) Generator overvoltage (red).
   l) Generator underfrequency (red).
   m) Generator overfrequency (red).

C. Master Control System and Monitoring Equipment: Paralleling and monitoring equipment, components, and accessories for multiple generators with the following features and characteristics:

1. Components and devices shall be mounted in the switchgear control section of the switchgear lineup.
2. Paralleled System Metering: 1 percent accuracy class or better to monitor total output of generator bus.
a. Ammeter, voltmeter, frequency meter, wattmeter, kilowatt-hour meter, power factor meter, kilovolt ampere, kilovolt ampere rating, and kilowatt demand meters.

1) For three-phase/four-wire systems, indicate line-to-line and line-to-neutral conditions on voltmeter.
2) Display all functions on the HMI device.

3. Full-Color HMI Device: Touchscreen with minimum viewing area of 60 square inches.
   a. Allows operator to monitor and control the complete system of paralleled generator sets.
   b. Screens shall include the following:
      1) Main Menu: Include date, time, and system status messages with screen push buttons to access one-line diagram, system controls, load controls, alarms, bus metering, and individual generator-set data.
      2) One-Line Diagram Screen: Depicting system configuration and system status by screen animation, screen colors, text messages, or pop-up indicators. Indicate the following minimum system conditions:
         a) Generator sets, buses, and paralleling circuit breakers energized/de-energized.
         b) Generator-set mode (run/off/auto).
         c) Generator-set status (normal/warning/shutdown/load-demand stop).
         d) Paralleling circuit-breaker status (open/closed/tripped).
         e) Bus conditions (energized/de-energized).
         f) Provide access to other screens.
      3) AC Metering Screen: Displays the following minimum meter data for the paralleling bus:
         a) Phase volts and amperes, kilowatt, kilovolt ampere, kilovolt ampere rating, power factor, frequency, kilowatt hour, and kilowatt demand.
         b) Real-time trend chart for system kilowatts and volts updated on not less than one-second intervals.
         c) A minimum of one historical trend chart for total system loads with intervals no shorter than five minutes and a minimum duration of four hours.
4) Generator-Set Control Screen: Provides control over individual generator sets from master system control panel. Includes the following minimum functions:
   a) Generator manual start/stop control (functional only when generator-set mounted control switch is in "Auto" position).
   b) Generator-set alarm reset.
   c) Manual paralleling and circuit-breaker controls.

5) Generator-Set Data Display Screen: Provide the following minimum parameters:
   a) Engine speed, oil pressure and temperature, coolant temperature, and engine operating hours.
   b) Three-phase voltage and current, kilowatt, power factor, and kilowatt hour.
   c) Generator control switch position and paralleling circuit-breaker position.
   d) All generator-set alarms.

6) System Control Screen: Password protected and with the following minimum functions:
   a) System Test Modes: Test with load/test without load/normal/retransfer time-delay override.
   b) Test with Load: Starts and synchronizes generator sets on paralleling bus; all loads are transferred to bus.
   c) Test without Load: Starts and synchronizes generator sets on paralleling bus but does not transfer loads to bus.
   d) Time adjustments for retransfer time delay, transfer time delay, system time delay on stopping, and system time delay on starting.

7) Load-Demand Control Screen: Monitors total load on system bus and controls number of generator sets running so that capacity tracks load demand.
   a) Load-Demand Control: On/off.
   b) Load-Demand Pickup Set Point: Adjustable from 90 to 40 percent in 5 percent increments.
   c) Load-Demand Dropout Set Point: Adjustable from 20 to 70 percent in 5 percent increments.
8) Manual Load Control Screen: Allows operator to manually add or delete generator sets from paralleled system in response to system load parameters.
   a) Indication of system available in kilowatts and amperes.
   b) Control functions allow manual addition/removal of generator sets on system, and activation of load-shed/load-restore functions.

9) Load-Add/Load-Shed Sequence Screen: Password protected and with the following minimum functions:
   a) Assigns "load-add sequence priority" to each load control relay with designation for relay operation after a set number of generator sets are online.
   b) Assigns "load-shed sequence priority" to each load control relay with designation for relay operation depending on number of generator sets online.

10) Alarm Summary and Run Report Screen:
   a) Lists most recent alarm conditions and status changes.
   b) Lists a minimum of the most recent 32 alarm conditions by name and time/date; acknowledges alarm conditions with time/date.
   c) For each start signal, lists start time and date, stop time and date, maximum kilowatt and ampere load on system during run time, and start and stop times of individual generator sets.

4. Solid-State System Status Panel:
   a. Provides visual alarm status indicator and alarm horn with silence/acknowledge push button.
   b. Annunciates the following conditions:

   1) Status, Light Only:
      a) Running Status: Display generator set number and "green" running-status light.
      b) Load demand mode (green).
      c) Priority Load Status: Display load number and "green" on-status light.
      d) System test (green).
      e) Remote system start (red).
f) Normal source available (green).
g) Connected to normal (green).
h) Generator source available (green).
i) Connected to generator source (green).

2) Status, Light and Alarm:

a) Load-Shed Level Status: Displays load number and red load-shed, status light.
b) Generator Alarm Status: Displays generator number and red "Check Generator" status light.
c) Controller malfunction (red).
d) Check station battery (red).
e) Bus overload (red).
f) System not in auto (red).

D. Description of System Operation:

1. Loss of Normal Power:

a. System receives "start" signal; all generator sets start and achieve rated voltage and frequency.
b. System closes the first generator set achieving 90 percent of rated voltage to paralleling bus.
c. "Priority load add" controls prevent overloading of system.
d. Remaining generator sets switched to synchronizers that control and then allow closure of generator sets to paralleling bus.
e. On closure to paralleling bus, each generator set assumes its proportional share of total load.

2. Failure of a Generator Set to Start or Synchronize:

a. After expiration of overcrank time delay, generator set shuts down and alarm is initiated.
b. Priority controller prevents overload of system bus.
d. Bus overload monitor protects bus from manual overloading.

3. Bus Overload:

a. On bus overload, load-shed control initiates load shedding.
b. If bus does not return to normal frequency within adjustable time period, additional load continues to be shed until bus returns to normal frequency.
c. Loads shed can be reconnected to bus only by manual reset at HMI.

4. Load-Demand Mode:
   a. With "load-demand" function activated, controller continuously monitors total bus load.
   b. If bus load is below preset limits for 15 minutes, demand controller shuts down generator sets in predetermined order until minimum number of sets are operating.
   c. On sensing available bus capacity diminished to set point, controller starts and closes generator sets to bus to accommodate load.

5. Return to Normal Power:
   a. Process starts on removal of start signals from system.
   b. When no load remains on paralleling bus, all generator breakers open, go through cool-down period, and shut down.
   c. If start signal is received during cool-down period, one generator set is reconnected to bus, and system operation follows that of "loss of normal power."

2.2 MANUFACTURED UNITS

A. Description: Factory assembled and tested and complying with IEEE C37.20.1.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded neutral system.

C. Indoor Enclosure Material: Steel.

D. Outdoor Enclosure Fabrication Requirements: Galvanized steel, weatherproof; integral structural-steel base frame with factory-applied asphaltic undercoating.

1. Provide each compartment or group of compartments with the following features:
   a. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.
   b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
   c. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
   d. Hinged front door with locking provisions.
e.  Interior light with switch.

f.  Weatherproof GFCI duplex receptacle.

g.  Power for heaters, lights, and receptacles to be provided by control power transformer.

2.  Provide weatherproof internal aisle construction with the following features:

  a.  Common internal aisle of sufficient width to permit protective-device withdrawal, disassembly, and servicing in aisle.

  b.  Aisle access doors with exterior padlocking provisions and interior panic latches.

  c.  Aisle space heaters operating at one-half or less of rated voltage, thermostatically controlled.

  d.  Vaporproof fluorescent aisle lights with low-temperature ballasts, controlled by wall switch at each entrance.

  e.  GFCI duplex receptacles, a minimum of two, located in aisle.

  f.  Aisle ventilation louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.

E.  Access: Fabricate enclosure with hinged, rear cover panels to allow access to rear interior of switchgear.

F.  Finish: Manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

G.  Phase-, Neutral-, and Ground-Bus Materials: Extend full length of switchgear.

  1.  Phase and Neutral Bus: Copper, silver plated at connection points.

  2.  Ground Bus: Copper, silver plated; minimum size 1/4 by 2 inches.

H.  Switchgear Components: Incorporate components as indicated on Drawings.

  1.  Instrument Transformers: Comply with IEEE C57.13.

     a.  Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

     b.  Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

  2.  Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems, listed and labeled by UL, and with the following features:
a. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
b. Switch-selectable digital display with the following features:

1) Phase Currents, Each Phase: Plus or minus 1 percent.
2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
4) Three-Phase Real Power: Plus or minus 2 percent.
5) Three-Phase Reactive Power: Plus or minus 2 percent.
6) Power Factor: Plus or minus 2 percent.
7) Frequency: Plus or minus 0.5 percent.
8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
9) Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

c. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Division 26 Section "Electrical Power Monitoring and Control."

d. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

3. Analog Instruments: Rectangular, 4-1/2 inches square, accurate within 1 percent; semiflush mounting, with antiparallax 250-degree scale and external zero adjustment; complying with ANSI C39.1.

a. Voltmeters: Cover an expanded scale range of normal voltage plus 10 percent.
b. Voltmeter Selector Switch: Rotary type with off position; provides readings of phase-to-phase and phase-to-neutral voltages.
c. Ammeters: Cover an expanded scale range of bus rating plus 10 percent.
d. Ammeter Selector Switch: Permits current reading in each phase and keeps current-transformer secondary circuits closed in off position.
e. Locate meter and selector switch on circuit-breaker compartment door for indicated feeder circuits only.
f. Watt-Hour Meters: Flush- or semiflush-mounting type, 5 A, 120 V, 3 phase, 3 wire; with 3 elements, 15-minute indicating demand register, and provision for testing and adding pulse initiation.
g. Recording Demand Meter: Usable as totalizing relay or indicating and recording maximum demand meter with 15-minute interval.

1) Operation: Counts and records a succession of pulses entering two channels.
2) Housing: Drawout, back-connected case arranged for semiflush mounting.

4. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.


6. Control Power Supply: Control power transformer supplies 120-V control circuits through secondary disconnect devices. Include the following features:
   a. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
   b. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
      1) Secondary windings connected through relay(s) to control bus to effect an automatic transfer scheme.
      2) Secondary windings connected through an internal automatic transfer switch to switchgear control power bus.
   c. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.
   d. Fuses are specified in Division 26 Section "Fuses."

7. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
   a. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   b. Conductors sized according to NFPA 70 for duty required.

I. Identification: Electrical identification devices and installation requirements are specified in Division 26 Section "Identification for Electrical Systems."
   1. Identify units, devices, controls, and wiring.
   2. Mimic Bus: Continuous mimic bus, applied to front of switchgear, arranged in one-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
      a. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
b. Medium: Painted graphics, as selected by Architect.
c. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer’s full range.

J. Control Battery System:

1. System Requirements: Battery shall have number of cells and ampere-hour capacity based on an initial specific gravity of 1.210 at 25 deg C with electrolyte at normal level and minimum ambient temperature of 13 deg C. Cycle battery before shipment to guarantee rated capacity on installation. Arrange battery to operate ungrounded.

2. Battery: Lead-calcium type in sealed, clear plastic or glass containers, complete with electrolyte, fully charged, and arranged for shipment with electrolyte in cells. Limit weight of each container to not more than 70 lb and cells per container to not more than 3. System batteries shall be suitable for service at an ambient temperature ranging from minus 18 to 25 deg C. Limit variation of current output to 0.8 percent for each degree below 25 deg C down to minus 8 deg C.

3. Rack: Two-step rack with electrical connections between battery cells and between rows of cells; include two flexible connectors with bolted-type terminals for output leads. Rate battery rack, cell supports, and anchorage for seismic requirements.

4. Accessories:
   a. Thermometers with specific-gravity correction scales.
   b. Hydrometer syringes.
   c. Set of socket wrenches and other tools required for battery maintenance.
   d. Wall-mounting, nonmetallic storage rack fitted to store above items.
   e. Set of cell numerals.

5. Charger: Static-type silicon rectifier equipped with automatic regulation and provision for manual and automatic adjustment of charging rate. Unit shall automatically maintain output voltage within 0.5 percent from no load to rated charger output current, with ac input-voltage variation of plus or minus 10 percent and input-frequency variation of plus or minus 3 Hz. Other features of charger include the following:
   a. DC ammeter.
   b. DC Voltmeter: Maximum error of 5 percent at full-charge voltage; operates with toggle switch to select between battery and charger voltages.
   c. Ground Indication: Two appropriately labeled lights to indicate circuit ground, connected in series between negative and positive terminals, and with midpoint junction connected to ground by normally open push-button contact.
   d. Capacity: Sufficient to supply steady load, float-charge battery between 2.20 and 2.25 V per cell and equalizing charge at 2.33 V per cell.
e. Charging-Rate Switch: Manually operated switch provides for transferring to higher charging rate. Charger operates automatically after switch operation until manually reset.

f. AC power supply is 120 V, 60 Hz, subject to plus or minus 10 percent variation in voltage and plus or minus 3-Hz variation in frequency. After loss of ac power supply for any interval, charger automatically resumes charging battery. Charger regulates rate of charge to prevent damage due to overload and to prevent fuses or circuit breakers from opening.

g. Protective Feature: Current-limiting device or circuit, which limits output current to rating of charger but does not disconnect charger from either battery or ac supply; protects charger from damage due to overload, including short circuit on output terminals.

h. Electrical Filtering: Reduces charger's audible noise to less than 26 dB.

2.3 METAL-CLAD, CIRCUIT-BREAKER SWITCHGEAR (1000 V AND LESS)

A. Refer to Low-Voltage Switchgear section (262300).

2.4 METAL-CLAD, MEDIUM-VOLTAGE, CIRCUIT-BREAKER SWITCHGEAR

A. Refer to Medium-Voltage Switchgear section (261300).

END OF SECTION 262313
SWITCHBOARDS
SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Instrumentation.
4. Control power.
5. Accessory components and features.
6. Identification.
7. Mimic bus.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with NEMA PB 2.

G. Comply with UL 891.
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H. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

I. Prepare, submit and obtain approval for all related work and other filings to the NYC Advisory Board as defined in the New York City Electrical Code and Chapter 34-Electrical Code Rules of Title 1 of the Rules of the City of New York.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform tests and inspections.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:

      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Submit the following Product Data: Dimensions and manufacturers’ technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Seismic Qualification Certificates.
   2. Operation and Maintenance Data.

G. When concrete pad-mounted, switchboard equipment enclosure shall be bolted to concrete or welded to pad steel (re-bar). High Tension equipment shall be connected to steel rails.

H. High Pressure Contact switches shall be used for all mains and ties 1200A and above in lieu of Bolted Pressure Contact switches.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lincoln Electric.
   3. All City Switchboard.
   4. Square D, Siemens, and GE are permitted at WCMC only.

B. National Branded manufacturers are not acceptable at CUMC.

C. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   3. Sections front and rear aligned.

D. Front- and Side-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
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3. Sections front and rear aligned.

E. Front- and Rear-Accessible Switchboards:

1. Main Devices: Fixed, individual or drawout mounted.
2. Branch Devices: Individually compartmented and drawout mounted.
3. Sections front and rear aligned.

F. Nominal System Voltage: As indicated.

G. Main-Bus Continuous: As indicated.

H. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

I. Indoor Enclosures: Steel, NEMA 250, Type 1.

J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

K. Outdoor Enclosures: Type 3R.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: Downward, rearward sloping roof; rear hinged doors for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of 30 inches; opening outwards; with panic hardware and provisions for cylinder lock.
4. Accessories: Fluorescent lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.

5. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer within the switchboard. Supply voltage shall be 120/208-V ac.
6. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.

L. Barriers: Between adjacent switchboard sections.
M. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

N. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

O. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company’s requirements; hinged sealed door; buses provisioned for mounting utility company’s current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

P. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

R. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

S. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

T. Pull Box on Top of Switchboard:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

U. Buses and Connections: Three phase, four wire unless otherwise indicated.

4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

5. Ground Bus: 1/4-by-2-inch, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

6. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard’s main and distribution sections. Provide for future extensions from both ends.

7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.


V. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

W. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

X. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.


3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
Switchboards

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integ rally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).


8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor material.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
   f. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
   g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
   j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed or Drawout circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time time adjustments.
   c. Ground-fault pickup level, time delay, and I^2t response.
4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: As indicated.

C. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
   b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.
4. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
   
a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   
b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
   
c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
   
d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
   
7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

E. Fuses are specified in Division 26 Section "Fuses."

2.3 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.


B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

   a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.


1. Meters: 4-inch diameter or 6 inches square, flush or semiflush, with antiparallax 250-degree scales and external zero adjustment.
2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

D. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

E. Feeder Ammeters: 2-1/2-inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

F. Watt-Hour Meters and Wattmeters:

2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.

G. Impulse-Totalizing Demand Meter:
2. Suitable for use with switchboard watthour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording five 15 30 <Insert time period>-minute integrated demand of totalized system.

2.4 CONTROL POWER
A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 ACCESSORY COMPONENTS AND FEATURES
A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
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B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.


D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.6 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

D. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

END OF SECTION 262413
PANELBOARDS
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
G. Prepare, submit and obtain approval for all related work and other filings to the NYC Advisory Board as defined in the New York City Electrical Code and Chapter 34-Electrical Code Rules of Title 1 of the Rules of the City of New York.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:

      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
F. Adjusting:
   1. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
   2. Set field-adjustable circuit-breaker trip ranges.
   3. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

G. Submit the following Product Data: Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
   1. Seismic Qualification Certificates.
   2. Panelboard Schedules.
   3. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Kitchen, Operating Rooms: NEMA 250, Type 4X, stainless steel.
   2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   3. Finishes:
      a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Isolated Ground Bus (if indicated): Adequate for branch-circuit isolated ground conductors; insulated from box.
   4. Extra-Capacity Neutral Bus (if indicated): Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
   5. Split Bus: Vertical buses divided into individual vertical sections.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Main and Neutral Lugs: Compression type.
   3. Ground Lugs and Bus-Configured Terminators: Compression type.
   4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating (if allowed): Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lincoln Electric
2. Atlas Switchboard
3. All City Switchboard
4. Square D, Siemens, and GE are permitted at WCMC only.

B. National Branded manufacturers are not acceptable at CUMC.

C. Panelboards: NEMA PB 1, power and feeder distribution type.

D. Doors: Door-in-door construction with inner door secured with vault-type latch with tumblers lock; keyed alike with S-11 Yale 47 key. Outer door secured with screws.

   1. For doors more than 36 inches high, provide two latches, keyed alike.

E. Mains: As indicated on drawings. Always main circuit breaker when located remote from upstream device.


G. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

H. Branch Overcurrent Protective Devices: Fused switches.

I. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.
5. Lincoln Electric
6. ElectroTech
7. Atlas Switchboard
8. All City Switchboard

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated.

D. Branch Overcurrent Protective Devices: Plug-in or Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Column-Type Panelboards: Not Permitted.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and $I^2t$ response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers for personnel protection: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip). Fail-safe type. GFCI circuit breakers are standard of design. Generally, GFCI devices (receptacles) shall not be used without expressed consent from Facilities Operations.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."

f. Shunt Trip: Voltage as indicated - trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.

i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.

j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.

l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."

2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

END OF SECTION 262416
MOTOR CONTROL CENTERS
SECTION 262419 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes motor-control centers for use on ac circuits rated 600 V and less.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain motor-control centers and controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for motor-control centers, including clearances between motor-control centers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the
following:

1. AKF

Motor-control centers
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2.2 MOTOR-CONTROL CENTERS

A. Wiring: NEMA ICS 3.

B. Enclosures: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
3. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor-control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
4. Wiring Spaces: Wiring channel in each vertical section for vertical and horizontal wiring to each unit compartment; supports to hold wiring in place.

C. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.3 BUSES

A. Material: Plated hard-drawn copper, 98 percent conductivity.

B. Ampacity Ratings: As indicated for horizontal and vertical main buses.

C. Neutral Buses: Full size.

D. Equipment Ground Bus: Noninsulated, horizontal configuration; adequate for equipment ground conductors; bonded to enclosure.
E. Horizontal Bus Arrangement: Main phase, neutral and ground buses extended with same capacity the entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections or equivalent.

F. Short-Circuit Withstand Rating: Same as short-circuit current rating of section.

2.4 FUNCTIONAL FEATURES

A. Description: Modular arrangement of controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center.

B. Controller Units: Combination controller units of types and with features, ratings, and circuit assignments indicated.

1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.

2. Provide units with short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center section.

3. Equip units in Type B and Type C motor-control centers with pull-apart terminal strips or drawout terminal boards for external control connections.


   a. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.


C. Overcurrent Protective Devices: Individual feeder-tap units through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.

D. Surge Suppression Device: Connect to motor-control center bus.

E. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
F. Spare Units: Type, sizes, and ratings indicated; installed in compartments indicated "spare."

2.5 ACROSS-THE-LINE CONTROLLERS


B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer source of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

2.6 REDUCED-VOLTAGE CONTROLLERS

A. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.


C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.

D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.

2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

3. LED indicators showing motor and control status, including the following conditions:

   a. Control power available.
   b. Controller on.
c. Overload trip.
d. Loss of phase.
e. Shorted silicon-controlled rectifier.

4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.

2.7 MULTISPEED CONTROLLERS

A. Multispeed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.8 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, pulse-width-modulated, variable frequency controller; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of standard or premium-efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: As indicated.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of 208 V, plus or minus 5, 480V, plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.
8. Ambient Temperature: 0 to 40 deg C.

E. Isolated control interface allows controller to follow control signal over an 11:1 speed range.
1. Electrical Signal: 4 to 20 mA at 24 V.

OR
2. Pneumatic Signal: 3 to 15 psig.

F. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
7. Reverse-phase protection.
8. Short-circuit protection.

H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Restarting during deceleration shall not damage controller, motor, or load.
J. Power- Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.

K. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.


M. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate controller output current, voltage, and frequency.

N. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker, NEMA AB 1, molded-case switch, NEMA KS 1, nonfusible switch, NEMA KS 1, fusible switch with lockable handle.

2.9 FEEDER OVERCURRENT PROTECTION


1. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
2. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.

3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
4. Intelligently Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

5. GFCI Circuit Breakers: Single- and two-pole configurations with 5 30-mA trip sensitivity.

6. Molded-Case Switch: Molded-case circuit breaker without trip units.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Compression style, suitable for number, size, trip ratings, and material of conductors.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.


4. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system.

5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

7. Auxiliary Switch Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts; "b" contacts operate in reverse of circuit-breaker contacts.

8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.


C. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses with lockable handle.

2.10 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Multifunction Digital-Metering Monitor: UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
2. Switch-selectable digital display of the following:
   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Three-Phase Real Power: Plus or minus 2 percent.
   e. Three-Phase Reactive Power: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.

3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

F. Phase-Failure and Undervoltage Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

END OF SECTION 262419
ENCLOSED BUS ASSEMBLIES
SECTION 262500 - ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Feeder-bus assemblies.
   2. Plug-in bus assemblies.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain enclosed bus assemblies and plug-in devices through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA BU 1, "Busways."

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests and inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of bus assembly including joints and plug-in units.
   1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   2. Perform 2 follow-up infrared scans of bus assembly, one at 4 months and the other at 11 months after Substantial Completion.
   3. Prepare a certified report identifying bus assembly checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

F. Set field-adjustable, circuit-breaker trip ranges and overload relay trip settings as indicated.

G. Submit the following Product Data: Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
   1. Show fittings, materials, fabrication, and installation methods.
   2. Indicate required clearances, method of field assembly, and location and size of each field connection.
   3. Detail connections to switchgear, switchboards, transformers, and panelboards.
5. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled bus-assembly layouts and relationships between components and adjacent structural, mechanical, and electrical elements.

6. Location of adjacent construction elements including light fixtures, HVAC and plumbing equipment, fire sprinklers and piping, signal and control devices, and other equipment.

7. Manufacturer Seismic Qualification Certification.

8. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:
   1. Siemens Energy & Automation, Inc.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work by special permission of NYPH engineering department include the following
   2. General Electric Company; Electrical Distribution & Control Division.
   3. Square D; Schneider Electric.

2.2 ENCLOSED BUS ASSEMBLIES

A. Feeder-Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.

   1. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for feeder-bus assemblies with reinforcement strong enough to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" when mounting provisions and attachments are anchored to building structure
   2. Voltage: As indicated; 3 phase; 100 percent neutral capacity.
   3. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
   4. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
   5. Ground:
      a. 50 percent capacity internal bus bars of material matching bus material.
New York Presbyterian Hospital
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6. Enclosure: Steel with manufacturer’s standard finish
7. Fittings and Accessories: Manufacturer’s standard.
8. Mounting: Arranged flat, edgewise, or vertically without derating.

B. Plug-in Bus Assemblies: NEMA BU 1, low-impedance bus assemblies in nonventilated housing; single-bolt joints; ratings as indicated.

1. Seismic Fabrication Requirements: Fabricate mounting provisions and attachments for switchboards with reinforcement strong enough to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" when mounting provisions and attachments are anchored to building structure.
2. Voltage: As indicated; 3 phase; 100 percent neutral capacity.
3. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
4. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation except at stabs and joints; plated surface at stabs and joints.
5. Ground:
   a. 50 percent capacity internal bus bar of material matching bus material.
6. Enclosure: Steel, with manufacturer’s standard finish, plug-in openings 24 inches o.c., and hinged covers over unused openings
7. Fittings and Accessories: Manufacturer’s standard.
8. Mounting: Arranged flat, edgewise, or vertically without derating.

2.3 PLUG-IN DEVICES

A. Fusible Switches: NEMA KS 1, heavy duty; with fuse clips to accommodate specified fuses; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position. See Division 26 Section "Fuses" for fuses and fuse installation requirements.

B. Molded-Case Circuit Breakers: NEMA AB 1; hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position.

C. SPD: NEMA 250, Type 1 enclosure with NEMA KS 1, fusible, disconnect switch and external handle to isolate TVSS from busway. TVSS product and installation requirements are specified in Division 26 Section "Surge Suppression Devices."

D. Motor Controllers: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
1. Control Circuit: 120 V; obtained from integral control power transformer with a control power of enough capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

2. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.
   a. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction. See Division 26 Section "Fuses" for fuses and fuse installation requirements.

3. Adjustable Overload Relay: Dipswitch selected for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Adjustable overload relays shall have Class II ground-fault protection with start and run delays to prevent nuisance trip on starting.

E. Multispeed Motor Controllers: Match controller to motor type, application, and number of speeds; include the following accessories:
   1. Compelling relay ensures motor starts only at low speed.
   2. Accelerating relay ensures properly timed acceleration through speeds lower than that selected.
   3. Decelerating relay ensures automatically timed deceleration through each speed.

END OF SECTION 262500
POWER DISTRIBUTION UNITS
SECTION 262600 - POWER DISTRIBUTION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes freestanding, prepackaged, power distribution units for transforming, conditioning, and distributing electrical power.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain a service center capable of providing training, parts, and emergency on-site repairs in less than eight hours maximum response time.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

   1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain power distribution unit and associated components specified in this Section from a single manufacturer with responsibility for entire power distribution unit installation.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Factory Tests: Design and routine tests shall comply with referenced standards.


C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

D. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification for circuit breakers, molded case; and for transformers, dry type, air cooled, low voltage, small. Certify compliance with test parameters.

2. Perform functional tests of power distribution units throughout their operating ranges. Test each monitoring, status, and alarm function.

F. Remove malfunctioning units, replace with new units, and retest as specified above.

G. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of conductor and bus connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

3. Prepare a certified report identifying connections checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

H. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.
I. Startup Service

1. Verify that power distribution units are installed and connected according to the Contract Documents.
2. Verify that electrical wiring installation complies with manufacturer’s submittal and with written installation requirements in Division 26 Sections.
3. Complete installation and startup checks according to manufacturer’s written instructions.

J. Adjusting

1. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
2. Adjust power distribution units to provide optimum voltage to equipment served throughout normal operating cycle of loads served. Record input and output voltages and adjustment settings, and incorporate into test results.

K. Submit the following Product Data: Include dimensioned plans, sections, and elevations. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Product Certificates.
2. Manufacturer Seismic Qualification Certification.
3. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Liebert Corporation; a division of Emerson.
2. Square D; Schneider Electric.
2.2 MANUFACTURED UNITS

A. Description: Integrated and coordinated assembly of power-line-conditioning and distribution components packaged in a single cabinet or modular assembly of cabinets each with full-swivel casters mounted to bottom frame. Include the following components:

1. Input-power, circuit-breaker section.
2. Isolation transformer.
3. SPD system.
4. Output panelboard(s).
5. Alarm, monitoring, and control system.

B. Provide units that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Unit Capacity Rating: Unit shall carry indicated rms kilovolt-ampere load continuously without exceeding rated insulation temperature for the following input voltage and load current:

1. Input Voltage: Within rated input-voltage tolerance band of unit.
2. Load Current: Minimum of 3.0 crest factor and 85 percent total harmonic distortion.

2.3 INPUT-POWER, CIRCUIT-BREAKER SECTION

A. Description: 3-pole, shunt-tripped, thermal-magnetic-type circuit breaker, rated for indicated interrupting capacity and 125 percent of input current of unit at 100 percent rated load.

1. Dual-Input Units:
   a. Two input circuit breakers arranged to provide transfer between two input-voltage sources.
   b. Controls and interfaces to allow both open- and closed-transition transfer between two input-voltage sources.
   c. Use a 120-V permissive signal from both upstream voltage sources to indicate acceptable conditions for closed-transition transfer.
   d. Open second circuit breaker automatically after closed-transition transfer is competed.
2.4 ISOLATION TRANSFORMER SECTION

A. Description: Dry-type, electrostatically shielded, three-phase, common-core, convection-air-cooled isolation transformer.

1. Comply with UL 1561 including requirements for nonsinusoidal load-current-handling capability defined by designated K-factor.
2. Cores: Grain-oriented, non-aging silicon steel, one leg per phase.
3. Coil Material and Insulation: Copper windings with a 220 deg C insulation class.
5. Output Impedance: 3.5 plus or minus 0.5 percent.
6. Regulation: 2 to 4 percent maximum, at full-resistive load; 5 percent maximum, at rated nonlinear load.
7. Taps: 6 full-capacity compensation taps at 2.5 percent increments; 2 above and 4 below nominal voltage.
8. Full-Load Efficiency: Minimum 96 percent at rated nonlinear load.
9. Magnetic-Field Strength External to Transformer Enclosure: Less than 0.1 gauss at 450 mm.
11. Electrostatic Shielding: Independently shield each winding with a double-copper, electrostatic shield arranged to minimize interwinding capacitance.
   a. Coil leads and terminal trips shall be arranged to minimize capacitive coupling between input and output connections.
   b. Shield Terminal: Separate, and marked "Shield" for grounding connection.
   c. Capacitance: Limit capacitance between primary and secondary windings to a maximum of 33 picofarads over a frequency range of 20 Hz to 1 MHz.
   d. Common-Mode Noise Attenuation: 120 dB minimum, 0.5 to 1.5 kHz; minus 65 dB minimum, 1.5 to 100 kHz.
   e. Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.

2.5 SPD SYSTEM

A. Description: Integrated SPD system complying with Division 26 Section "Surge Protective Devices," to protect unit panelboard, and having the following features:
1. Disconnect Device: Manual, three-pole, fused disconnect switch to de-energize SPD system while permitting power distribution units to continue operation. Fuses are rated at 200-kA interrupting capacity.

2. Nonlinear Loading: System shall accommodate rated-load current with a minimum 3.0 crest factor and 85 percent total harmonic distortion.

2.6 OUTPUT PANELBOARDS

A. Description: Panelboards complying with Division 26 Section "Panelboards" except for mounting provisions. Mount in front of power distribution units behind flush doors. Include the following features:

1. Construction: 42 pole, 240 V, 3 phase; capable of accepting branch circuit breakers rated to 100 A.
3. Panelboard Phase, Neutral and Ground Buses: Copper, with neutral bus at least 1.732 times the nominal phase bus rating.
4. Isolated Ground Bus: Copper, adequate for branch-circuit equipment ground conductors; insulated from supports.
5. Branch Circuit Breakers: Bolt or Plug on.
7. Access Panels: Arranged so additional branch-circuit wiring can be installed and connected in the future.

2.7 POWER DISTRIBUTION UNIT CONTROLS

A. Include the following control features:

1. Emergency, power-off input terminals for connection to remote power-off switch.
2. Over-under alarm shutdown with automatic unit disconnection for the following alarm conditions:
   a. High temperature.
   b. High and low input or output voltage.
   c. Phase loss.
   d. Ground fault.
   e. Reverse phase rotation.
3. Ground-fault protection with automatic system shutdown.
4. Alarm Contacts: Electrically isolated, Form C (one normally open and one normally closed), summary alarm; contact set shall change state if any monitored function goes into alarm mode.

5. Remote Power-Off Control: Control circuit with connection to shunt trip of power distribution unit main power circuit breaker and terminals for connection to one or more remote power-off, push-button stations.

6. Auxiliary Control Output.

2.8 MONITORING, STATUS, AND ALARM ANNUNCIATION

A. Description: Microprocessor-based monitoring, status, and alarm annunciation panel mounted flush in front of power distribution unit to provide status display and failure-indicating interface for the following:

1. Power Monitoring:
   a. Input Voltage: Line to line, rms.
   b. Output Voltage: Line to line, rms.
   c. Output Voltage: Line to neutral, rms.
   d. Output current.

2. Status Indication: Unit on.

3. Alarm Annunciation:
   a. High temperature.
   b. High and low input voltage.
   c. High and low output voltage.
   d. Phase loss.
   e. Ground fault.
   f. Frequency.
   g. Phase rotation.
   h. TVSS module failure.

4. Audible Alarm and Silencing Switch: Alarm sounds when alarm indication occurs. Silencing switch shall silence audible alarm but leave visual indication active until failure or other alarm conditions are corrected.
2.9 SOUND LEVEL

A. General: Fully assembled products have a minimum of 3 dB less than the maximum sound levels prescribed for transformers of corresponding ratings when factory tested according to IEEE C57.12.91.

2.10 FINISHES

A. Manufacturer’s standard finish over corrosion-resistant pretreatment and primer.

END OF SECTION 262600
SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes equipment for utility company’s electricity metering and electricity metering by Owner.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Test Owner’s electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kilowatt rating, 10% of Meter Scale kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.
5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.
B. Submit the following Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual.

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
3. Manufacturer Seismic Qualification Certification for Electricity-Metering Equipment.
4. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

1. Manufacturers:

   b. General Electric Company; Electrical Distribution & Control Div.
   c. Siemens Energy & Automation, Inc.
   d. Square D; Schneider Electric.

2. Housing: NEMA 250, Type 1 or 3R enclosure.

   a. Structural strength of the housing, its anchorage and component attachment provisions, and anchorage devices recommended for anchoring the housing in
place shall be adequate to prevent separation of equipment and its components from their installed positions during a seismic event as defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3. Minimum Short-Circuit Rating: 200,000 amperes symmetrical at rated voltage.
4. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers or fusible switch, series-combination rated by breaker manufacturer to protect downstream feeder and branch circuit breakers.
5. Feeder Circuit Breakers: Series-combination-rated molded case units, rated to protect circuit breakers in downstream tenant and house loadcenters and panelboards that have 10,000-A interrupting capacity.
   a. Identification: Complying with Division 26 Section "Identification for Electrical Systems" with legend identifying tenant's address.
   b. Physical Protection: Tamper resistant, with hasp for padlock.
6. Meter Socket: Type as approved by utility company, with rating coordinated with indicated tenant feeder circuit rating.

2.3 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Manufacturers:

1. E-MON L.P.
2. Osaki Meter Sales, Inc.
3. Square D; Schneider Electric.

B. Kilowatt-Hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.
3. Demand Signal Communication Interface: Match signal to remote building automation system input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
4. Enclosure: NEMA 250, Type 1 or 3R minimum, with hasp for padlocking or sealing.
5. Identification: Comply with Division 26 Section "Identification for Electrical Systems."
6. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
7. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.
   a. Type: Split and solid core.
8. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.
9. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

END OF SECTION 262713
WIRING DEVICES
SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
5. Isolated-ground receptacles.
6. Hospital-grade receptacles.
7. Snap switches and wall-box dimmers.
8. Solid-state fan speed controls.
9. Wall-switch and exterior occupancy sensors.
10. Communications outlets.
12. Cord and plug sets.
13. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform tests and inspections and prepare test reports.
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz.

D. Submit the following Product Data:
   1. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
   2. Operation and Maintenance Data.

E. Device standard is Hubbell. Leviton, Pass & Seymour, and Cooper are permitted alternates when manufactured to “Hubbell Standard” at CUMC only.
   1. WCMC will accept Hubbell Hospital Grade Only
   2. WCMC: Any tamper resistant outlet shall be Hubbell Hospital Grade only.

F. Receptacle Color Code and Standard:
   1. Normal = White or per Architectural design.
   2. Emergency = Red with LED backlight (No back light at WCMC).
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:
   1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work by special permission of NYPH engineering department include the following at CUMC:
   2. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
   3. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2.2 STRAIGHT BLADE RECEPTACLES

A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL8310 (single), HBL8300H (duplex).
      b. Leviton; 8310 (single), 8300 (duplex).
      c. Pass & Seymour; 9301-HG (single), 9300-HG (duplex).
      d. Cooper; 8300 (duplex).

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL8300SG.
      b. Leviton; 8300-SGG.
      c. Pass & Seymour; 63H.
      d. Cooper; TR8300.

   2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section. For use in all Pediatric and Public Waiting locations. Including pediatric ICU and excluding Operating Rooms.
2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HGF8300.
   b. Leviton; 6898-HG.
   c. Pass & Seymour; 2091-SHG.
   d. Cooper; HGF20.

C. Approval must be granted from Facilities Operations to use GFCI receptacle device for design. Fail-safe GFCI protection shall be provided integral to circuit breakers per specification section 262416. GFCI protected receptacles shall be labeled as such on cover plate of device.

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous ( Classified) Locations: Comply with NEMA FB 11 and UL 1010.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper Crouse-Hinds.
   b. EGS/Appleton Electric.
   c. Killark; a division of Hubbell Inc.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL2310.
   b. Leviton; 2310.
   c. Pass & Seymour; L520-R.
   d. Cooper; L520R.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; IG2310.
   b. Leviton; 2310-IG.

2. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.8 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
      b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
      c. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
      d. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).

C. Pilot Light Switches, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HPL1221PL for 120 V and 277 V.
      b. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
      c. Pass & Seymour; PS20AC1-PLR for 120 V.
      d. Cooper; 2221PL for 120 V and 277 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL1221L.
      b. Leviton; 1221-2L.
      c. Pass & Seymour; PS20AC1-L.
      d. Cooper; 2221L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.
E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1557.
   b. Leviton; 1257.
   c. Pass & Seymour; 1251.
   d. Cooper; 1995.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1557L.
   b. Leviton; 1257L.
   c. Pass & Seymour; 1251L.
   d. Cooper; 1995L.

2.9 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. Rating as indicated; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
2.10 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; WS1277.
   b. Leviton; ODS 10-ID.
   c. Pass & Seymour; WS3000.
   d. Watt Stopper (The); WS-200.
   e. Cooper; 6111 for 120 V, 6117 for 277 V.

2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

B. Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; AT120 for 120 V, AT277 for 277 V.
   b. Leviton; ODS 15-ID.

2. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

C. Long-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; ATP1600WRP.
   b. Leviton; ODWWV-IRW.
   c. Pass & Seymour; WA1001.
   d. Watt Stopper (The); CX-100.

2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft..

D. Long-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; ATD1600WRP.
   b. Leviton; ODW12-MRW.
c. Watt Stopper (The); DT-200.

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft..

E. Wide-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; ATP120HB. 
b. Leviton; ODWHB-IRW. 
c. Pass & Seymour; HS1001. 
d. Watt Stopper (The); CX-100-3. 

2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft..

F. Exterior Occupancy Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Leviton; PS200-10. 
b. Watt Stopper (The); EW-100-120. 

2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.11 COMMUNICATIONS OUTLETS

A. Voice Outlet:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 3560-6. 
b. Leviton; 40649. 

2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 6e. Comply with UL 1863.
B. Combination TV and Telephone Outlet:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 3562.
   b. Leviton; 40595.

3. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.12 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.


4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.13 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

D. Voice and Data Communication Outlet: As indicated.
2.14 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Wiremold Company (The).

B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: As indicated.
2. Size: Selected to fit nominal cored holes in floor and matched to floor thickness.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
4. Closure Plug: Arranged to close unused cored openings and reestablish fire rating of floor.
5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 6e voice and data communication cables.

2.15 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Wire: No. 12 AWG.
2.16 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch- square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.

2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.

3. Finishes: Manufacturer’s standard painted finish and trim combination.

4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.

5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.

6. Voice and Data Communication Outlets: As indicated.

END OF SECTION 262726
SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600-V ac.

1.2 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with UL 248-11 for plug fuses.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

F. Submit the following Product Data:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.
   7. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Cooper Bussmann, Inc. (LP series)

2.2 CARTRIDGE FUSES
   A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 FUSE APPLICATIONS
   A. Cartridge Fuses:
      1. Service Entrance: Class L, time delay.
      2. Feeders: Class L, time delay, Class J, time delay.
      3. Motor Branch Circuits: Class RK1, time delay.
      4. Other Branch Circuits: Class RK1, time delay, Class J, time delay.
5. Control Circuits: Class CC, time delay.

END OF SECTION 262813
SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Fused power circuit devices
   4. Shunt trip switches.
   5. Molded-case circuit breakers (MCCBs).
   7. Enclosures.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
   3. Perform over current trip test for circuit breakers over 200A based on HEMA standards. The use of secondary injection for solid state trip devices shall be for trip settings of 200 amps up to 400A. Provide primary injection testing for trip settings over 400A.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Adjusting:
   1. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

G. Submit the following Product Data:
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Time-current coordination curves.
   7. Seismic Qualification Certificates.
   8. Operation and Maintenance Data.

H. When concrete pad-mounted, switchboard equipment enclosure shall be bolted to concrete or welded to pad steel (re-bar). High Tension equipment shall be connected to steel rails.

I. High Pressure Contact switches shall be used for all mains and ties 1200A and above in lieu of Bolted Pressure Contact switches.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Subject to compliance with requirements, provide product by one of the following:

   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.
   5. Lincoln Electric Prod.
   8. All City Switchboard.
B. Type HD, Heavy Duty, Single Throw, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   5. Lugs: Compression type, suitable for number, size, and conductor material.
   7. Accessory Control Power Voltage: Remote mounted and powered, Voltage as indicated.

2.2 NONFUSIBLE SWITCHES

A. Subject to compliance with requirements, provide product by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.
   5. Lincoln Electric Prod
   6. Electro Tech
   7. Atlas Switchboard
   8. All City Switchboard.

B. Type HD, Heavy Duty, Single Throw, 240 600-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Lugs: Compression type, suitable for number, size, and conductor material.
5. Accessory Control Power Voltage: Remote mounted and powered; Voltage as indicated.

2.3 FUSED POWER CIRCUIT DEVICES

A. High-Pressure, Butt-Type Contact Switch 1200A and larger: UL 977; operating mechanism shall use butt-type contacts and a spring-charge mechanism to produce and maintain high-contact pressure when switch is closed

1. Manufacturers:
   a. General Electric Co.; Electrical Distribution & Control Division

2. Main Contact Interrupting Capability: Twelve times the switch current rating, minimum.
3. Operating Mechanism: Manual handle operation to close switch stores energy in mechanism for closing and opening.
   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
   b. Mechanical Trip: Operation of mechanical lever or push button or another device causes switch to open.

4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.

5. Service-Rated Switches: Labeled for use as service equipment.

6. Ground-Fault Relay: Comply with UL 1053. Self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
   a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground fault indicator.
   b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
c. No-Trip Relay Test: Operation of “no-trip” test control permits ground-fault simulation test without tripping switch.

d. Test Control: Simulates ground fault to test relay and switch (or relay only if “no-trip” mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens

2.4 SHUNT TRIP SWITCHES

A. Subject to compliance with requirements, provide product by one of the following:

1. Cooper Bussmann, Inc.
2. Ferraz Shawmut, Inc.

B. General Requirements: Comply with UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Form C alarm contacts that change state when switch is tripped.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Subject to compliance with requirements, provide product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and $I^2t$ response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."

6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

8. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

9. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

11. Zone-Selective Interlocking: Integral with trip unit; for interlocking ground-fault protection function.

12. Electrical Operator: Provide remote control for on, off, and reset operations.


2.6 MOLDED-CASE SWITCHES

A. Subject to compliance with requirements, product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Alarm Switch: One NO contact that operates only when switch has tripped.
8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.

2.7 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

END OF SECTION 262816
ENCLOSED CONTROLLERS
SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.
   2. Reduced-voltage controllers.
   3. Multispeed controllers.

1.2 WORK INCLUDED

A. The mechanical contractor is to provide motor, motor controllers and VFD’s. The mechanical contractor to install motor, motor controllers and VFD’s. The Electrical contractor is to wire all motors and motor controllers.

B. The mechanical contractor shall be responsible for coordinating all requirements of the motor and controller manufacturer.

C. If this contractor elects to substitute or increase motor horsepower over that specified, the cost of motor, motor controllers and electrical changes shall be borne by this contractor.

D. Each motor except as noted, shall be provided with a combination disconnection means and across-the-line magnetic starter with push button stations mounted on cover or variable frequency drive. Coordinate requirements between trades (electrical and mechanical contractors).

E. For automatically or remotely controlled motors, furnish hand off auto (HOA) selector switches in place of the push buttons.

F. Provide manually operated motor starters of the proper size for all motors less than 1/2 hp which are not automatically controlled. Starters for motors 175 watts or less shall consist of a snap switch with thermal overload protection where such protection is not an integral part of the motor.

G. Combination magnetic starters for all motors shall have thermal overload, pilot light, low voltage protection in all three phases. Include a control transformer for each magnetic starter.
to provide 120 volt control power with 3 sets of spare normally closed or normally open contacts

H. Starters for motors 75 hp and above shall be solid state electronic soft start type starters.

I. Disconnect switches are to be provided by the electrical contractor if not integral with equipment.

J. Provide enclosures for motor controllers suitable for operating environment.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.
1.4 FACILITY OPERATIONS REQUIREMENTS

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer’s Field Service:
   1. Inspect controllers, wiring, components, connections, and equipment installation.
   2. Assist in field testing of equipment.

C. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters, Motor Control - Adjustable Speed Drive Systems." Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Adjusting:
   1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Submit the following Product Data: Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   1. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited.
   2. Manufacturer Seismic Qualification Certification.
   4. Load-Current and List of Settings of Adjustable Overload Relays.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Eaton Corporation; Cutler-Hammer Products.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Siemens/Furnas Controls.
6. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.
C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.
D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:
   a. Control power available.
   b. Controller on.
   c. Overload trip.
   d. Loss of phase.
   e. Shorted silicon-controlled rectifier.
4. Motor running contactor operating automatically when full voltage is applied to motor.

2.4 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.5 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty with digital readout in hours.

1. Ammeter: Output current, with current sensors rated to suit application.
2. Voltmeter: Output voltage.
3. Frequency Meter: Output frequency.

F. Multifunction Digital-Metering Monitor: Listed and labeled by an NRTL acceptable to authorities having jurisdiction, microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
2. Switch-selectable digital display of the following:
   a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Three-Phase Real Power: Plus or minus 2 percent.
e. Three-Phase Reactive Power: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Integrated Demand with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

3. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.


H. Current-Sensing, Phase-Failure Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

END OF SECTION 262913
VARIABLE-FREQUENCY MOTOR CONTROLLERS
SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

1.2 WORK INCLUDED

1. The mechanical contractor is to provide motor, variable frequency controllers (VFD’s). The mechanical contractor to install motor, motor controllers and VFD’s. The Electrical contractor is to wire all motors and VFD’s.

2. The mechanical contractor shall be responsible for coordinating all requirements of the motor and VFD manufacturer.

3. If this contractor elects to substitute or increase motor horsepower over that specified, the cost of motor, motor controllers and electrical changes shall be borne by this contractor.

4. Each motor except as noted, shall be provided with a combination disconnecting means and across-the-line magnetic starter with push button stations mounted on cover or variable frequency drive. Coordinate requirements between trades (electrical and mechanical contractors).

5. For automatically or remotely controlled motors, furnish hand off auto (HOA) selector switches in place of the push buttons.

6. Combination magnetic starters for all motors shall have thermal overload, pilot light, low voltage protection in all three phases. Include a control transformer for each magnetic starter to provide 120 volt control power with 3 sets of spare normally closed or normally open contacts.

7. Starters for motors 75 hp and above shall be solid state electronic soft start type starters.

8. Disconnect switches are to be provided by the electrical contractor if not integral with equipment.

9. Provide enclosures for VFD’s suitable for operating environment.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.4 FACILITY OPERATIONS REQUIREMENTS

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service:

1. Inspect controllers, wiring, components, connections, and equipment installation.
2. Assist in field testing of equipment.

C. Perform the following field tests and inspections and prepare test reports:
1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Adjusting:
   1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Submit the following Product Data: Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   1. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited.
   2. Manufacturer Seismic Qualification Certification.
   3. Operation and Maintenance Data.
   5. Load-Current and List of Settings of Adjustable Overload Relays.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:


2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

   1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:
   1. Input ac voltage tolerance of 208 V, plus or minus 5, 480 V, plus or minus 5 percent.
   2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
   3. Minimum Efficiency: 96 percent at 60 Hz, full load.
   5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   6. Starting Torque: 100 percent of rated torque or as indicated.
   7. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
   1. Electrical Signal: 4 to 20 mA at 24 V.
   2. Pneumatic Signal: 3 to 15 psig (20 to 104 kPa).

F. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to a minimum of 22 seconds.
   4. Deceleration: 2 to a minimum of 22 seconds.
   5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors.
   2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
   5. Instantaneous line-to-line and line-to-ground overcurrent trips.
   7. Reverse-phase protection.
   8. Short-circuit protection.
H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

J. Power- Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

M. Input Line Conditioning: Integral input 5% impedance line reactors.

N. VFC Output Filtering: As indicated.

O. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.


Q. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

R. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Pneumatic Input Signal Interface: 3 to 15 psig.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.

4. Output Signal Interface:
   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).

5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.
S. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

T. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

U. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
   1. Provide Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors for motors 75 horsepower and greater.

V. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker or molded-case switch with lockable handle.

W. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
4. DC-link voltage (VDC).
5. Motor torque (percent).
7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.
ENGINE GENERATORS
SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for emergency/standby power supply with the following features:

1. Diesel engine.
2. Cooling system.
3. Control and monitoring.
4. Performance requirements for sensitive loads.
5. Load banks.
6. Outdoor enclosure.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer’s authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours’ normal travel time from Installer’s place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer’s standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.
1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37.

H. Comply with NFPA 99.

I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

J. Comply with UL 2200.

K. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

N. Application for Registration: Provide all necessary information to Owner for filing the fuel engine generator to the New York City Department of Environmental Protection.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Warranty
1. Manufacturer’s standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
a. Warranty Period: 2 years from date of Substantial Completion.

B. Source Quality Control
   1. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   3. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
      a. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
      b. Full load run.
      c. Maximum power.
      d. Voltage regulation.
      e. Transient and steady-state governing.
      g. Safety shutdown.
      h. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
      i. Report factory test results within 10 days of completion of test.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

D. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections:
   1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
   3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
c. Verify acceptance of charge for each element of the battery after discharge.
d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

F. Coordinate tests with tests for transfer switches and run them concurrently.

G. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

H. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

I. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

J. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
K. Remove and replace malfunctioning units and retest as specified above.

L. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

M. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

N. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

O. Submit the following Product Data: Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.
3. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
4. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
7. Manufacturer Seismic Qualification Certification.
8. Source quality-control test reports.
10. Operation and Maintenance Data.
11. Warranty: Special warranty specified in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:
   1. Caterpillar; Engine Div.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work by special permission of NYPH engineering department include the following:
   2. Atlantic Detroit Diesel.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated.
   2. Output Connections: Three-phase, four wire.
   3. Nameplates: For each major system component to identify manufacturer’s name and address, and model and serial number of component.

D. Generator-Set Performance for Sensitive Loads:
   1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
2. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.

3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.

4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

A. Fuel: Fuel oil, Grade DF-2

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:


2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.


   a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.

   b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer’s engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 75 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
   8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
      b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.


e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

   a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: 275 gallons.

3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.

4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.

5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.

6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.
2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.


2. Switchgear Construction: Freestanding unit complying with Division 26 Section "Low-Voltage Switchgear."


C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 2 system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.

2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.

4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
2.8 LOAD BANK

A. MANUFACTURERS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Avtron Loadbank.
      b. Simplex, Inc.

B. Description: Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive unit capable of providing a balanced 3-phase, delta-connected load to generator set at specified percent rated-system capacity, at 80 percent power factor, lagging. Unit may be composed of separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.

C. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.

D. Reactive Load Elements: Epoxy-encapsulated reactor coils.

E. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

F. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

G. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

H. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge.

I. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in
cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

J. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

K. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

L. Provide a radiator mounted load bank as required on a per project basis. Coordinate with NYPH:

1. Diesel engines need a minimum amount of load to insure proper operation, typically the 40% to 50% range of the kilowatt rating. A load bank is utilized as a supplemental load to bring genset loading to a minimum operating capacity. A low load capacity has an adverse effect on generator set performance

2. A load bank is required to accommodate generator purposely oversized to accommodate for future growth.

3. A radiator mounted load bank is a cost-effective type of load bank as it does not have an integral cooling fan. The radiator style load bank is designed to be installed on the radiator of the genset and uses the airflow through the radiator to cool its load elements.

4. A load bank can meet maintenance required by NFPA 70, National Electrical Code and fulfills the exercising requirements of NFPA 99 & 100.

5. Utilizing a load bank to supplement the source load or test load will help maintain the engine's optimum output rating and will eliminate wet stacking. Wetstacking is a condition that can exist in diesel engines when all the fuel is not completely burned and passes into the exhaust system. In Diesel generators, wetstacking usually occurs because the engine is running at only a small percentage of its capacity; therefore the engine does not achieve its optimum operating temperature.

6. The exhaust temperature must be maintained at the specific minimum level to regenerate the oxidation catalyst system to meet air quality standards.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Prefabricated or pre-engineered walk-in enclosure with the following features:

2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
3. 208/120V, 100A MCB, 3ph, 4 wire, 30 pole load center.
4. Space Heater: Thermostatically controlled and sized to prevent condensation.
5. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
7. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
8. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
9. Muffler Location: External to enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.10 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

3. Number of Layers Three.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.11 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer’s standard finish over corrosion-resistant pretreatment and compatible primer.

END OF SECTION 263213
STATIC UNINTERRUPTIBLE POWER SUPPLY
SECTION 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes three-phase, on-line, double-conversion, static-type, UPS installations complete with transient voltage surge suppression, input harmonics reduction, rectifier-charger, battery, battery disconnect device, inverter, static bypass transfer switch, maintenance bypass/isolation switch, battery monitoring.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer’s authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in Part 3 "Performance Testing" Article.

C. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs with eight hours’ maximum response time.

D. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

E. Source Limitations: Obtain the UPS and associated components specified in this Section from a single manufacturer with responsibility for entire UPS installation.
F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

G. UL Compliance: Listed and labeled under UL 1778.

H. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

I. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

J. Application for Registration: Provide all necessary information to Owner for filing the UPS to the New York City Department of Finance.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Factory test complete UPS system before shipment. Use actual batteries that are part of final installation. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's option.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.
D. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer’s written instructions and as listed below to demonstrate condition and performance of each UPS component:

1. Inspect interiors of enclosures, including the following:
   a. Integrity of mechanical and electrical connections.
   b. Component type and labeling verification.
   c. Ratings of installed components.

2. For units rated 150 kVA and more load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit’s rating. Use instruments calibrated, within the previous six months according to NIST standards.
   a. Simulate malfunctions to verify protective device operation.
   b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
   c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
   d. Test output voltage under specified transient-load conditions.
   e. Test efficiency at 50, 75, and 100 percent of rated loads.
   f. Test remote status and alarm panel functions.
   g. Test battery-monitoring system functions.

E. Seismic-restraint tests and inspections shall include the following:

1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
2. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

F. Retest: Correct deficiencies and retest until specified requirements are met.

G. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

1.4 PERFORMANCE TESTING

A. Coordinate with NYPH if performance testing of UPS installation is required.
B. Engage the services of a qualified power quality specialist to perform tests and activities indicated below.

C. Monitoring and Testing Schedule: Perform monitoring and testing in a single 10-day period.

   1. Schedule monitoring and testing activity with Owner, through Architect, with at least 14 days' advance notice.
   2. Schedule monitoring and testing after Substantial Completion, when the UPS is supplying power to its intended load.

D. Monitoring and Testing Instruments: Three-phase, recording power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at UPS input terminals and at input terminals of loads served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power-line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:

   2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
   3. Frequency transients.
   4. Voltage swells and sags.
   5. Voltage Impulses: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
   6. High-frequency noise.
   7. Radio-frequency interference.
   8. THD of the above currents and voltages.
   9. Harmonic content of currents and voltages above.

E. Monitoring and Testing Procedure:

   1. Exploratory Period: For approximately the first two days make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these preliminary measurements with the objective of identifying optimum UPS, power system, load, and instrumentation set-up conditions for subsequent test and monitoring operations.
   2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS with respect to values specified in Part 2, and to highlight any need to adjust, repair, or modify the UPS or any distribution system or load component that may influence its performance or that may require better power quality.

b. Perform load and UPS power source switching and operate the UPS on generator power during portions of test period according to directions of Owner's power quality specialist.

c. Operate the UPS and its loads in each mode of operation permitted by UPS controls and by the power distribution system design.

d. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.

F. Monitoring and Testing Assistance by Contractor:

1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.

2. Observe monitoring and testing operations; ensure that UPS and distribution and load equipment warranties are not compromised.

3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by power quality specialist. Specialist shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.

4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.

5. Engage the services of the UPS manufacturer’s factory-authorized service representative periodically during performance testing operations for repairs, adjustments, and consultations.

G. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Coordinate simultaneous recordings made on UPS input and load circuits.

H. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in report:

1. Description of corrective actions performed during monitoring and survey work and their results.
2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.

3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.

4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.

5. Recommendations for operating, adjusting, or revising UPS controls.

6. Recommendation for alterations to the UPS installation.

7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.

8. Recommendations for power distribution system revisions.

9. Recommendations for adjusting or revising electrical loads, their connections, or controls.

I. WARRANTY

1. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

   a. Warranted Cycle Life for Premium Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:

      | Discharge Rate | Discharge Duration | Discharge End Voltage | Cycle Life |
      |----------------|--------------------|-----------------------|------------|
      | 8 hours        | 8 hours            | 1.67                  | 40 cycles  |
      | 30 minutes     | 30 minutes         | 1.67                  | 125 cycles |
      | 15 minutes     | 1.5 minutes        | 1.67                  | 750 cycles |

2. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.

   a. Special Warranty Period: Two years from date of Substantial Completion.

J. Submit the following Product Data: Product Data: Include data on features, components, ratings, and performance for each UPS component indicated.
1. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

2. Wiring Diagrams: Power, signal, and control wiring.

3. Manufacturer Seismic Qualification Certification.

4. Factory Test Reports: Comply with specified requirements.

5. Field Quality-Control and Performance Test Reports.

6. Operation and Maintenance Data.

7. Warranties: Special warranties specified in this Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE DESCRIPTION

A. Automatic operation includes the following:

1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.

2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.

3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.

4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.

5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.

6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.

7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.

9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection between the following three conditions without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

2.2 SERVICE CONDITIONS

A. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.

1. Ambient Temperature for Electronic Components: 32 to 104 deg F
2. Ambient Temperature for Battery: 41 to 95 deg F.
3. Relative Humidity: 0 to 95 percent, noncondensing.
4. Altitude: Sea level to 4000 feet

2.3 PERFORMANCE REQUIREMENTS

A. The UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear
load with a load crest factor of 3.0, under the following conditions or combinations of the 
following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal 
   voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal 
   frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and 
   the largest single harmonic component is a minimum of 5 percent of the fundamental 
   value.
5. Load is 30 percent unbalanced continuously.

B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load 
current at 80 percent power factor, duration of supply is 15 minutes.

C. Input Voltage Tolerance: System steady-state and transient output performance remains within 
specified tolerances when steady-state ac input voltage varies plus 10, minus 10 percent 
from nominal voltage.

D. Maximum Energizing Inrush Current: Six times the full-load current.

E. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or 
   minus 2 percent over the full range of battery voltage.

F. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, 
   load, and battery voltage.

G. Limitation of harmonic distortion of input current to the UPS shall be as follows:
   
   1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger 
      circuits shall limit THD to 10 percent, maximum, at rated full UPS load current, for 
      power sources with X/R ratio between 2 and 30.

H. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 
   percent RMS for any single harmonic, for rated full load with THD up to 50 percent, with a 
   load crest factor of 3.0.

I. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 
   minutes, and 150 percent for 30 seconds in all operating modes.

J. Maximum Output-Voltage Transient Excursions from Rated Value: For the following 
instantaneous load changes, stated as percentages of rated full UPS load, voltage shall
remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:

1. 50 Percent: Plus or minus 5 percent.
2. 100 Percent: Plus or minus 5 percent.
3. Loss of AC Input Power: Plus or minus 1 percent.
4. Restoration of AC Input Power: Plus or minus 1 percent.

K. Input Power Factor: A minimum of 0.85 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.


2.4 UPS SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:

1. Liebert Corporation; a division of Emerson. NX or NXL series.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work by special permission of NYPH engineering department include the following:

1. Eaton UPS Systems.
2. Mitsubishi Electric Automation, Inc.
3. APC; by Schneider Electric.

C. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

D. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

E. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

F. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41.
G. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

H. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them), shall be designed and fabricated to withstand static and seismic forces.

I. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

2.5 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer’s written instructions for battery terminal voltage and charging current required for maximum battery life.

2.6 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.7 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.
2.8 BATTERY

A. Description: Two strings, valve-regulated, premium, heavy-duty, recombinant, lead-calcium units, factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.

1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.

2. Manufacturers:
   b. EnerSys, Inc.
   c. HOPPECKE.
   d. Mitsubishi Electric Automation, Inc.
   e. Powerware; an Invensys Company.

B. Seismic-Restraint Design: Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them), shall be designed and fabricated to withstand static and seismic forces.

2.9 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications: Labeled LED.

1. Quantitative indications shall include the following:
   a. Input voltage, each phase, line to line.
   b. Input current, each phase, line to line.
   c. Bypass input voltage, each phase, line to line.
   d. Bypass input frequency.
   e. System output voltage, each phase, line to line.
   f. System output current, each phase.
   g. System output frequency.
   h. DC bus voltage.
i. Battery current and direction (charge/discharge).
j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:

a. Normal operation.
b. Load-on bypass.
c. Load-on battery.
d. Inverter off.
e. Alarm condition.

3. Alarm indications shall include the following:

a. Bypass ac input overvoltage or undervoltage.
b. Bypass ac input overfrequency or underfrequency.
c. Bypass ac input and inverter out of synchronization.
d. Bypass ac input wrong-phase rotation.
e. Bypass ac input single-phase condition.
f. Bypass ac input filter fuse blown.
g. Internal frequency standard in use.
h. Battery system alarm.
i. Control power failure.
j. Fan failure.
k. UPS overload.
l. Battery-charging control faulty.
m. Input overvoltage or undervoltage.
n. Input transformer overtemperature.
o. Input circuit breaker tripped.
p. Input wrong-phase rotation.
q. Input single-phase condition.
r. Approaching end of battery operation.
s. Battery undervoltage shutdown.
t. Maximum battery voltage.
u. Inverter fuse blown.
v. Inverter transformer overtemperature.
w. Inverter overtemperature.
x. Static bypass transfer switch overtemperature.
y. Inverter power supply fault.
z. Inverter transistors out of saturation.
aa. Identification of faulty inverter section/leg.
bb. Inverter output overvoltage or undervoltage.
cc. UPS overload shutdown.
dd. Inverter current sensor fault.

ee. Inverter output contactor open.

ff. Inverter current limit.

4. Controls shall include the following:

   a. Inverter on-off.
   b. UPS start.
   c. Battery test.
   d. Alarm silence/reset.
   e. Output-voltage adjustment.

D. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.10 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.

2. Switch shall electrically isolate other UPS components to permit safe servicing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full UPS load current.

D. Mounting Provisions: Separate wall- or floor-mounted unit.

E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

2.11 OUTPUT DISTRIBUTION SECTION

A. Panelboards: Comply with Division 26 Section "Panelboards," except provide assembly integral to UPS cabinet.
2.12 MONITORING BY REMOTE STATUS AND ALARM PANEL

A. Description: Labeled LEDs on panel faceplate indicate five basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.13 BASIC BATTERY MONITORING

A. Manufacturers:

1. Albercorp; Hawker Siddeley.
2. BTECH Inc.
3. MetriXX USA, Inc.
4. Powerware; an Invensys Company.

B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

C. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.

D. Annunciation of Alarms: At UPS control panel.

END OF SECTION 263353
POWER FACTOR CORRECTION EQUIPMENT
SECTION 263533 - POWER FACTOR CORRECTION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes automatic power factor correction equipment rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions, operating characteristics of multiple capacitor cells or elements, and data on features, ratings, and performance.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.


C. Manufacturer Seismic Qualification Certification: Submit certification that capacitor equipment will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
3. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
4. Dimensioned Outline Drawings of Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.
5. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: Testing agency.
E. Field quality-control test reports.

F. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Lists of spare parts and replacement components recommended for storage at Project site.
   2. Detailed instructions covering operation under both normal and abnormal conditions.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined in OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE 18 and NEMA CP 1.

D. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.4 FACILITY OPERATIONS REQUIREMENTS

A. Factory test power factor correction equipment before shipment. Comply with NEMA CP 1. Include the following:
   1. Routine capacitor production tests, including short-time overvoltage, capacitance, leak, and dissipation-factor tests.
   2. Functional test of all operations, controls, indicators, sensors, and protective devices.
B. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each power factor correction capacitor element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Manufacturer’s Field Service:
   1. Inspect capacitors, wiring, components, connections, and equipment installation.
   2. Assist in field testing of equipment.

D. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, “Capacitors and Reactors - Capacitors.” Certify compliance with test parameters.

E. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

F. Adjust for optimum automatic power factor correction.

G. WARRANTY
   1. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace capacitor-bank components that fail in materials or workmanship within specified warranty period.
      a. Special Warranty Period for Capacitor Cells: Five years from date of Substantial Completion.

H. Submit the following Product Data: Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.
   2. Manufacturer Seismic Qualification Certification.
   3. Operation and Maintenance Data.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Power Factor Correction Capacitors and Automatic Power Factor Correction Units:
      a. ABB Control, Inc.
      b. General Electric Company; Business Information Center.
      c. Square D; Division of Schneider Electric.

2.2 CAPACITORS, GENERAL

A. Construction: Multiple capacitor cells or elements, factory wired in three-phase groups and mounted in metal enclosures.

B. Capacitor Cells: Dry, metallized-dielectric, self-healing type. Each cell shall be encapsulated in thermosetting resin inside plastic container.

C. Cell Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

D. Capacitor-Bank Fuses: Current-limiting, noninterchangeable type; factory installed in each phase and located within the equipment enclosure. Features include the following:
   1. Interrupting Capacity: 200,000 A, minimum.
   2. Fuse Ratings and Characteristics: As recommended by capacitor manufacturer.

E. Discharge Resistors: Factory installed and wired. Resistors may be omitted if permitted by NFPA 70.

F. Enclosure: NEMA 250, steel or aluminum, arranged to contain the fluid leakage from capacitor cells; factory equipped with mounting brackets suitable for type of mounting indicated.
   1. Indoor Enclosures: NEMA 250, Type 12 or as indicated.
   2. Outdoor Enclosures: NEMA 250, Type 4, equipped with watertight conduit connections.
2.3 FIXED CAPACITORS

A. Description: Integrally fused, unless otherwise indicated.

B. Internal Wiring: Factory wired, ready for field connection to external circuits at a single set of pressure terminals.

2.4 AUTOMATIC POWER FACTOR CORRECTION UNITS

A. Comply with NEMA ICS 2.

B. Description: Capacitor banks, contactors, controls, and accessories factory installed in independent enclosures. Units include a separately mounted current transformer to sense current in the power circuit being corrected and to provide input to unit controls.

C. Performance Requirements: Controls permit selection of a target power factor, adjustable to any value between unity and 0.80 lagging. Controls continuously sense the power factor on circuits being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a contractor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Switch only one capacitor bank at a time.

D. Controls: Solid-state, microprocessor-based controls, including the following:
   1. Undervoltage relay that interrupts capacitor switching and disconnects capacitors for power supply interruptions longer than 15 minutes.
   2. "Advance" and "Retard" push buttons on the control panel to permit manually controlled capacitor-bank switching.

E. Contactors: Three pole; rated for the repetitive high-inrush-switching duty in the capacitor application.

F. Buses: Plated copper.

G. Fuses for Protection of Capacitor Banks: Rated to protect contactor, interconnecting wiring, and capacitors.

H. Inductors: Air-core-type, connected in capacitor circuits; rated to limit switching surges to within contactor ratings.
I. Precharge Capacitor Circuit: Resistive, precharge circuit to charge capacitors prior to switching and to limit switching surges to within contactor ratings.

J. Mechanical Bracing for Current-Carrying Parts: Adequate to withstand the maximum fault current to which they may be exposed.

K. Identification of Energized Capacitor Banks: LED indicating lamps on front panel.

L. Enclosure: NEMA 250, Type 1 3R 12, steel or aluminum, with hinged door and hand-operated catch. Door shall be interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.

M. Local Display: LED or liquid-crystal digital type, mounted in door of enclosure, indicating the following:
   1. Target and actual power factors accurate to plus or minus 1 percent of reading.
   2. Steps energized.
   3. Step reconnection delay.
   4. Real and reactive currents.
   5. Voltage THD.
   6. Alarm codes.

N. System Alarms: Alarm relay and local display indication of the following conditions:
   1. Low power factor.
   2. Leading power factor.
   3. Frequency not detected.
   4. Overcurrent.
   5. Overvoltage.
   6. Overtemperature.
   7. Excessive voltage THD.
   8. Capacitor overload.

O. Current Transformer: Type, configuration, and ratio to suit sensing and mounting conditions.

P. Main Circuit Breaker: Operable from outside the enclosure to disconnect the unit.
   1. Operating handle can be padlocked.

Q. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with electrical power monitoring and control
network. Communication module shall have capability to transmit the following data to remote monitoring devices:

1. System in alarm.
2. Power factor set-point.
3. Corrected power factor.
4. Number of capacitor steps activated.
2.5 FACTORY FINISH

A. Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.

END OF SECTION 263533
TRANSFER SWITCHES
SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Bypass/isolation switches.
3. Remote annunciation systems.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than 4, 8 hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches and remote annunciators through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 99.

F. Comply with NFPA 110.

G. Comply with UL 1008 unless requirements of these Specifications are stricter.

H. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.


   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.


   a. Verify grounding connections and locations and ratings of sensors.

D. Coordinate tests with tests of generator and run them concurrently.

E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Remove and replace malfunctioning units and retest as specified above.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

H. Submit the following Product Data: Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

I. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
2. Operation and Maintenance Data.

J. WCMC: Any ATS 400A and above shall have a bypass.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Contactor Transfer Switches:
   a. Emerson; ASCO Power Technologies, LP.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
G. Neutral Switching. Where four-pole switches are indicated, provide overlapping neutral contacts.

H. Battery Charger: For generator starting batteries.
   1. Float type rated 10 A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

G. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
   a. Initiation occurs without active control of generator.
   b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
4. Failure of power source serving load initiates automatic break-before-make transfer.

H. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

I. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

J. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
K. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

5. Test Switch: Simulate normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.

   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10
to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

b. Push-button programming control with digital display of settings.

c. Integral battery operation of time switch when normal control power is not available.

2.4 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.

2. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.

3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.

4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.

5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.

6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.

7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.
2.5 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
2. Switch position.
3. Switch in test mode.
4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.
2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.6 ACCESSORIES

A. All transfer switches to include the following accessories, model numbers based on ASCO.

1. 30B Load-shedding circuit initiated by removal of customer-supplied control voltage.
2. 72E Serial to Ethernet converter with embedded web pages.
3. 23B Three phase ammeter with selector switch (with current transformers and shorting blocks).

END OF SECTION 263600
LIGHTNING PROTECTION FOR STRUCTURES
SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes lightning protection for buildings.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is an NRTL or who is certified by LPI as a Master Installer/Designer.

B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

C. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. UL Inspection: Provide inspections as required to obtain a UL Master Label for system.

C. Submit the following Product Data: Product Data: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
   1. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL.
   2. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
   3. Field inspection reports indicating compliance with specified requirements.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ERICO International Corporation.
   2. Harger Lightning Protection, Inc.
   3. Independent Protection Co.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class I or II, copper, solid, unless otherwise indicated.

C. Stack-Mounting Air Terminals: Solid copper.

D. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 26 Section “Grounding and Bonding for Electrical Systems” and with standards referenced in this Section.

END OF SECTION 264113
SURGE PROTECTIVE DEVICES FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS
SECTION 264313 – SURGE PROTECTIVE DEVICES FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes SPD’s for low voltage power services.

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. Comply with IEEE C62.41.2, and test devices according to IEEE C62.45.

D. Comply with NEMA LS 1.

E. Comply with UL 1283 and UL 1449.

F. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Testing: Perform the following field tests and inspections and prepare test reports:
   1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
   2. Complete startup checks according to manufacturer’s written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
4. Remove and replace malfunctioning units and retest as specified above.

B. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

C. Submit the following Product Data: Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
   1. Product Certificates: For SPD devices, from manufacturer.
   2. Field quality control report.
   3. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.
   4. Warranties: Special warranties specified in this Section.

PART 2 · PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. Square D; Schneider Electric.
   2. Current Technology, Inc.
   5. Siemens Energy & Automation, Inc.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protection Device Description:
   1. Listed to UL 1449 by OSHA approved NRTL.
   2. Single replaceable surge module.
   3. Fuses, rated at 200 kA interrupting capacity.
   4. Fabrication using bolted compression lugs for internal wiring.
   5. Integral fully surge rated disconnect switch.
6. Redundant suppression circuits.
7. Redundant replaceable modules.
8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
9. LED indicator lights for power and protection status.
10. Audible alarm, with silencing switch, to indicate when protection has failed.
11. One set of dry contacts rated at 5A and 250 VAC for remote monitoring of protection status. Coordinate with building power monitoring and control system.
12. Surge-event operations counter.


C. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 277/480V or 120/208V, 3-phase, 4-wire services (dependent upon service) shall be as follows:

1. Line to Neutral: 1200 V for 277/480V, 700 V for 120/208V.
2. Line to Ground: 1200 V for 277/480V, 700 V for 120/208V.
   Neutral to Ground: 1500 V for 277/480V, 1000 V for 120/208V.

2.3 ENCLOSURES

A. NEMA 250, with type matching the enclosure of switchboard being protected.

END OF SECTION 264313
SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.

1.2 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

F. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
   1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.3 FACILITY OPERATIONS REQUIREMENTS

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries and Emergency Fluorescent Ballast: 7 years from date of Substantial Completion.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic and Electromagnetic Ballasts: Five years from date of Substantial Completion.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

1. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

D. Submit the following Product Data: Product Data: Product Data:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 23 Section "Diffusers, Registers, and Grilles."
7. Life, output, and energy-efficiency data for lamps.
8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

9. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.

10. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

11. Warranties: Special warranties specified in this Section

12. All light fixtures shall be chain supported regardless of weight.

PART 2 - PRODUCTS

2.1 NEWPH INTERIOR GUIDELINES

A. Refer to NEWPH Interior Guidelines for specific lighting design requirements.

The Guidelines are available to consultants and NYP staff through the internet site,

https://e-net.nyp.org/sites/facilities/default.aspx

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

K. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 23 Section "Diffusers, Registers, and Grilles."

1. Air Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat Removal Units: Air path leads through lamp cavity.
3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.
2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 42 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.85 or higher.
7. Power Factor: 0.95 or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.


C. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

D. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 <Insert value> percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 <Insert value> percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

E. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
   a. High-Level Operation: 100 percent of rated lamp lumens.
   b. Low-Level Operation: 50 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher, unless otherwise indicated.
   9. Power Factor: 0.95 or higher.
   10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
   1. Emergency Connection: Operate fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   2. Night-Light Connection: Operate one fluorescent lamp continuously.
   3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Night-Light Connection: Operate one fluorescent lamp in a remote fixture continuously.
5. Housing: NEMA 250, Type 1 enclosure.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
2.6 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers’ standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 15 percent.
4. Transient Voltage Protection: IEEE C62.41, Category A or better.
5. Lamp Current Crest Factor: 1.5 or less.
6. Power Factor: .90 or higher.
7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
8. Protection: Class P thermal cutout.
9. Retain subparagraph and associated subparagraphs below for bi-level ballasts.
10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.
   a. High-Level Operation: 100 percent of rated lamp lumens.
   b. Low-Level Operation: 50 percent of rated lamp lumens.
   c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 <Insert value> percent of rated lamp lumens without flicker.
   a. Ballast Input Watts: Reduced to a maximum of 50 <Insert value> percent of normal at lowest dimming setting.
b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.

C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

D. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   a. Restrike Range: 105- to 130-V ac.
   b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2. Minimum Starting Temperature: Minus 40 deg F.
3. Open-circuit operation shall not reduce average lamp life.

2.7 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

   1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
   2. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal
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voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.8 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
2.9 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.


E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

END OF SECTION 265100
EXTERIOR LIGHTING
SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1  SUMMARY

A. This Section includes the following:
   1. Exterior luminaires with lamps and ballasts.
   2. Luminaire-mounted photoelectric relays.
   3. Poles and accessories.

1.2  QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

1.3  FACILITY OPERATIONS REQUIREMENTS

A. Special Warranty for Luminaires, Metal Corrosion, Color Retention and poles: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting
unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries and Emergency Fluorescent Ballast: 5 years from date of Substantial Completion.

B. Illumination Tests:
1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.
2. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

C. Submit the following Product Data:
1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.
12. Manufactured pole foundations.
13. Pole and Support Component Certificates.
15. Warranties: Special warranties specified in this Section.

PART 2 - PRODUCTS

2.1 NYPH INTERIOR GUIDELINES
1. Refer to NYPH Interior Guidelines for specific lighting design requirements.
2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer’s standard paint applied to factory-assembled and tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, “Solvent Cleaning,” to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, “White Metal Blast Cleaning,” or SSPC-SP 8, “Pickling.”

2. Exterior Surfaces: Manufacturer’s standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

2.3 LUMINAIRE-MOUNTED PHOTOLELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.

2. Adjustable window slide for adjusting on-off set points.
2.4 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures 0 deg F and higher.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F and higher.

D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.5 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

C. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall
have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
   a. Restrike Range: 105- to 130-V ac.
   b. Maximum Voltage: 250-V peak or 150-V ac RMS.

2. Minimum Starting Temperature: Minus 40 deg F.

2.6 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature as specified, and average rated life of 24,000 hours, minimum.

   1. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.

B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature as specified.

C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature as specified.

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80 <Insert value>, and color temperature as specified.

2.7 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 “Structural Analysis Criteria for Pole Selection” Article, with a gust factor of 1.3.

   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.2 to obtain the equivalent projected area to be used in pole selection strength analysis.
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B. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section “Cast-in-Place Concrete.”

E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

END OF SECTION 265600
NURSE CALL/CODE BLUE SYSTEMS (BY BIOMED & IT)
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SECTION 275223 – NURSE CALL/CODE BLUE SYSTEMS

1.1 SUMMARY

A. This section specifies the furnishing, installing, and testing of a complete networked Audio-Visual Nurse Call system to be installed at New York Presbyterian Hospital. The system outlined here is to include all necessary devices that provide the functions listed in this specification.

1. Nurse call system and wiring shall be furnished and installed by this contractor.

2. Provide a raceway system and backboxes. Minimum size of conduit shall be ¾ inch, unless noted otherwise. Extend ¾ inch conduit up to above corridor accessible ceiling. Where devices are indicated to be installed in plaster ceilings, provide conduit to accessible ceiling space. All raceways shall comply with all preceding specification requirements relative to raceways and fittings.

3. Cables supported and tied within cable tray as required, to obtain an installation neat in appearance. Cables shall be tagged with identification labels.

4. Furnish 120 volt circuit to power each of the equipment cabinets as indicated on the drawings.

5. Install wiring per manufacturer’s representative’s shop drawing submittal.

6. Maintain record drawing of any wiring installation that deviates from shop drawing submittal.

1.2 QUALITY ASSURANCE

1. The systems shall be the product of a manufacturer or an agency experienced in such work.

2. Source Limitations: Obtain nurse call equipment components from owner, which are to be supplied through one source from a single manufacturer.

3. All items shall be of the latest technology, no discontinued models or products are acceptable.

4. Installer Qualifications: Manufacturer’s Authorized Representative who is trained and approved for installation of units required for this project.
5. The Manufacturer or the Authorized Representative shall provide proof that within 60 miles of the project they maintain:
   a. A full complement of parts to support the installation.
   b. Offer service by fully trained and qualified technicians during normal working hours.
   c. Will supply parts and service without delay and at a reasonable cost.

1.3 Regulatory Requirements:

1. Electrical Components, Devices, and Accessories: Listed and labeled according to UL1069 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC in concert with the 2014 New York City Building Code, and all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

3. Conform to NFPA 99

4. Conform to NFPA 110

5. Conform to HIPAA regulations relating to paging and public address systems.

6. Systems may be subject to inspection and require accreditation from agencies such as OSHPOD and Joint Commission if mandated by the owner. Suppliers of all systems must include all documentation and staff to support the owner during these inspections and certifications.

7. Underwriter’s Laboratories UL-1069 current release

8. NFPA – National Fire Protection Association


10. ADA – Americans with Disabilities Act

11. EIA – Electronic Industry Association

12. NEMA – National Electrical Manufacturers Association – Installation Standards

13. U.S. Dept. of Labor / Occupational Safety and Health Administration State Hospital Code / Joint Commission of Hospitals – Nurse Call

14. Canadian Standards Association
1.4 SUBMITTALS

A. Any supplying contractor proposing equipment which is not the base standard for this specification must provide full submittals at the time of bid. This option shall be exercised at the discretion of the OWNER/specifying authority.

B. Prior to submission of bid, the supplying contractor shall submit six (6) complete submittal sets. Each set shall consist of the following:

1. Product Data: For each type of product indicated.
2. Shop Drawings: Detail the system including the following:
   a. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
   b. Wiring Diagrams: Power, signal, and control wiring.
   c. Station Installation Details: For built-in equipment; dimensioned and to scale.
   d. Equipment Cabinet Drawings: Dimensioned and to scale.
3. Coordination Drawings: Detail system components that fit, match, and line up with provisions made for equipment specified in other Sections or in separate contracts:
   a. Head-wall units.
   b. Power columns.
4. Manufacturer Certificates: Signed by manufacturers certifying that nurse call equipment complies with requirements.
5. Manufacturer’s Warranty Statement.
6. Field Tests Reports and Observations: Include record of final adjustments certified by Installer.
7. Operation and Maintenance Data: For nurse call equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   a. Operating instructions.
   b. Troubleshooting guide.
   c. Wiring diagrams and terminal identification.
   d. Equipment parts list.
   e. Product data for types and sizes of wires and cables used.
1.5 COORDINATION

A. Coordinate patient control units (pillow speakers and feature bed side rails) to provide remote control of devices, such as televisions and lighting, which are not part of the nurse call system.

B. Coordinate wiring paths and maintenance access at locations listed below. Coordinate trim features and finishes at these locations to present a unified design appearance.
   1. Patient head-wall units.
   2. Nurse consoles.
   3. Nurse station.

1.6 WARRANTY

A. The installing manufacturer’s representative shall guarantee all labor, parts, and installation for a period of 1 year from substantial completion or first beneficial use of the system.

B. Provide manufacturer five (5) year warranty for the nurse call / code blue system.

C. Provide manufacturer one (1) year warranty for accessories including call cords and pillow speakers.

PART 2 -

SCHEDULE 0 -

PRODUCT DATA SHEET 0 -

2.1 MANUFACTURERS

A. Manufacturers: The products specified shall be the standard models of a single reputable manufacturer. Subject to compliance with requirements, provide products by the following:

   1. Tek-Tone.
   2. Hill-Rom
3. Telcom

2.2 SYSTEM REQUIREMENTS

A. Provide a complete turn-key Nurse Call Communications system operating as a single integrated solution. Match components and interconnections for optimum performance of all specified functions.

B. All Nurse Call Communications Network devices shall be UL-1069 listed including all Gateways, Nurse Consoles, Staff Terminals, Data Switches, Patient Stations, Staff Stations, Room Controllers, Dome Lights, Zone Lights, Peripheral Stations, Pillow Speakers, and Call Cords.

C. The system shall be a life safety grade design with continuous 24/7 availability without the need for routine rebooting to install updates such as operating system or virus definition updates. As such, the core life safety UL1069 components of the system shall not utilize a Personal Computer, embedded Personal Computer, or commercial operating system vulnerable to software virus attacks. The system shall remain fully operational during any programming or firmware updates with no loss of active calls, active communications, or the need to reboot the system.

D. System shall be network-based with a distributed architecture allowing remote survivability should the network connection be lost. All inter-Gateway, Gateway to Nurse Console, Gateway to Staff Terminal, and Gateway to Room Controller communications shall utilize Voice over IP and Ethernet technology.

E. For superior intelligibility, all audio communication among nurse call devices must be digital full duplex audio, including audio communication to/from Nurse Consoles, Staff Terminals, and to each individual room for Staff, Duty, and Patient Stations. System shall provide at least eight (8) simultaneous audio connections for each group of up to 31 Patient and Staff areas to provide fast, instantaneous communications without waiting for an available audio path. The system’s simultaneous audio path capacity shall be included in the base system and not require any additional licensing or costs.

F. The system shall be capable of supporting at least 1,000 unique call priority levels each with a unique call tone/voice prompt. The system shall include standard call tones/voice prompts with the ability to import WAV files to customize the call tones/voice prompts to each facility’s requirements. Throughout the entire system, all Nurse Consoles, Staff
Terminals, Duty Stations with intercom, Staff Stations, and Patient Stations will annunciate the same call tones/voice prompts for each respective call priority.

G. The system shall be capable of supporting at least 1,000 Nurse Consoles, and any combination of 50,000 Patient, Staff, Duty, and Peripheral Stations.

H. All wiring between Gateways, Nurse Consoles, Staff Terminals, Data Switches, Room Controllers, Zone Lights, Staff Stations, Duty Stations, and Patient Stations shall utilize standard CAT 5E or CAT 6 cabling and terminations with optional power distribution cabling for long runs; additional non-category cabling required to each individual room or shielded audio cable shall not be required between any of these components.

I. System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to ESD (electrostatic discharges) of up to 25,000 volts in an environment with a relative humidity of 20 percent or less. Patient Stations must be rated to ESD of 100,000 volts in an environment with a relative humidity of 20 percent or less.

J. Nurse Call Communications Network provides continuous supervision of all devices on the system including: Gateways, Nurse Consoles, Staff Terminals, Data Switches, Room Controllers, Lights, Zone Lights, Staff Stations, Duty Stations, Patient Stations, and Peripheral Stations. Any supervision failure will alarm at predetermined Nurse Console(s) (indicating the room number and type of failure) and to a technician’s pocket pager through the pocket page interface option.

K. All end-devices, including Nurse Consoles, Room Controllers, Zone Lights, Staff Stations, Duty Stations, Patient Stations, and Peripheral Stations:
   1. May be hot-swapped without needing to power down the local system.
   2. All employ plug-in terminations for simple service or replacement.
   3. Are easily cleaned and impervious to common hospital cleaning agents.

L. All system programming and firmware updates use a flexible GUI application for simple on-site or remote administration of all system attributes. All system programming and updates are done through a direct, facility LAN, or remote VPN connection.
2.3 EQUIPMENT AND FUNCTIONALITY SPECIFICATIONS

A. Data Switch
   Provide as shown on plans. Each Data Switch shall provide the following:
   1. Interconnection of any combination of up to 8 Nurse Call Gateways.
   2. An uplink port to interconnect multiple data switches as part of complete distributed Nurse Call Communications Network.
   3. Mounts in standard 19 inch data rails or equipment racks.

B. Nurse Call Gateway, Provide as shown on plans. Each Nurse Call Gateway shall provide the following:
   1. Interconnecting local Room Controllers, Zone Lights, Patient Stations, Staff Stations, Duty Station, Nurse Consoles, and Staff Terminals for all power, communications, and call routing.
   2. Non-blocking duplex digital audio communications between Nurse Consoles, Staff Terminals and to each individual room for Staff, Duty, and Patient Stations providing a minimum of eight (8) simultaneous speech paths from each Gateway.
   3. Continuous supervision of all connected components.
   4. Mounting in standard 19 inch data rails or equipment racks.

C. Power Supply
   1. Power and integrated battery backup for associated Nurse Call Gateway and all local components including: Nurse Consoles, Staff Terminals, Room Controllers, Zone Lights, Patient Stations, Staff Stations, Duty Stations, and Peripheral Stations.
   2. Mounts in standard 19 inch data rails or equipment racks.

D. Touchscreen VoIP Nurse Consoles and VoIP Staff Terminals, Provide as shown on plans. Each Nurse Console and Staff Terminal shall provide the following:
   1. Utilize VoIP over an Ethernet LAN connection to communicate with the associated Nurse Call Gateway(s) and Data Switch(es).
   2. Full duplex digital audio communications with the choice of handset communications for semi-private conversations or communications through the built-in speaker and separate microphone.
3. 5.7 inch color backlit touchscreen with:
   a. 320 x 240 pixel resolution.
   b. 12 or 24 hour time display synchronized to facilities network time with automatic updates for daylight saving time changes.

4. Touchscreen menu-driven operation for all functions plus four (4) tactile buttons for the commonly used features:
   b. Tone Silence button: mutes incoming call audible alert tone. Any new call annunciating at the Nurse Console/Staff Terminal restarts call alert tone.
   c. Quit button: backs users out of current operation and back to previous menu screen.
   d. Home button: cancels all menu driven operations and returns to the home screen.

5. Call Annunciation:
   a. Displays a minimum of four (4) outstanding patient and/or staff calls with individual elapsed timer per call and automatic sequencing of calls by priority and/or time of call so that oldest or highest priority call is always displayed first.
   b. Call tone annunciation for the highest priority call displayed.
   c. Four (4) call status level indicators (ROUTINE, URGENT, EMERGENCY, CODE) to quickly identify highest priority call level.
   d. Programmable timer for unanswered calls with automatic upgrade, and display of outstanding calls.
   e. User selectable Hi/Low call-in tone level.
   f. Ability to respond to calls out of sequence by touching active call on the screen.
   g. Three (3) modes of viewing outstanding calls: two (2) line “Zoom In” view shows the detail of up to two (2) outstanding calls clearly visible from up to ten feet away, four (4) line “Zoom In” view shows the detail of up to four (4) outstanding calls, and “Zoom Out” view shows up to twenty (20) outstanding calls.

6. Communications:
   a. Handsfree full duplex communication when communicating with Patient, Staff, or Duty stations. Stations can converse with Nurse Console/Staff Terminal hands-free and from anywhere within the room where the intercom station is located.
   b. Semi-private audio communication over integrated handset.
   c. Open voice audio communication over integrated speaker and microphone. During communications with an intercom station, lifting the handset on Nurse
Console disconnects speaker and microphone and transfers conversation to the handset.

d. Ability to direct dial to establish audio communications with any Patient Station, Staff Station, Duty Station, Nurse Console, or Staff Terminal located anywhere on the nurse call network.

e. Individual talk/listen volume control for each Patient Station, Staff Station, and Duty Station.

f. Ability to monitor one or several user-selected rooms simultaneously.

7. Audio Paging:
   a. Programmable page groups with visual display of group designator while paging.
   b. Ability to group page up to ten (10) rooms simultaneously with visual display of selection.
   c. Optional ability to simultaneously page all rooms within a unit or ward.
   d. Automatic page to only those locations where caregivers have registered.

8. Service Requirements:
   a. Upon answering a call or dialing a room directly, the ability to set a Green, Orange, Amber, or Stat level Service Requirement to notify the appropriate caregiver(s) assigned to that patient.
   b. Ability to display beds with outstanding Green, Orange, Amber, or Stat Service Requirements. Touching displayed room establishes communications with that room.
   c. Programmable timers for unanswered Service Requirements with automatic upgrade and call back.

9. Staff Registration and Staff Follow:
   a. Provisions for staff registration using Staff Registration Stations or Real Time Locating System (RTLS) integration.
   b. Ability to display locations of all registered Green, Orange, and/or Amber level caregivers. Touching displayed room establishes communications with that room.
   c. Ability to selectively forward call tones to locations where caregivers are registered. In the staff follow mode, the room station’s cancel button acts as a momentary Tone Silence button. When a call tone is temporarily silenced, the tones regenerate with any subsequent call annunciation.
   d. Ability to automatically forward Code Blue level call tones to locations where caregivers are registered.
10. Room Swing and Day/Night Transfer:
   a. Ability for up to ten (10) pre-designated rooms to be temporarily rerouted
      (“swung”) to a Nurse Console or Staff Terminal in an adjoining area. Once a
      room has been swung, all calls originating from that room will only annunciate
      at the other Console/Terminal. The Console/Terminal that swung the room shall
      be capable of returning the swung room to annunciate at the original
      Console/Terminal.
   b. Ability of all rooms reporting to a Nurse Console or Staff Terminal to be rerouted
      (“day/night transferred”) to any other Console/Terminal in an adjoining area.
      Normal operation is restored to the original Console/Terminal when a staff
      member “releases” the day/night transfer.

11. Optional features:
   a. Wall-mount with handset.
   b. Wall-mount without handset.

12. Optional features:

    Patient Stations: Provide Single Patient or Dual Patient Stations as shown on plans.
    Each station shall provide the following:
   a. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone
      with talk/listen volume set on a Station by Station basis at any Nurse Console or
      Staff Terminal.

13. Momentary action Cancel button, monitor LED indicator, and call-placed LED
    indicator.

14. RJ-45 field wiring receptacle for Cat-5e/6 wiring to associated Room Controller.

15. Blue LED to illuminate the station in low ambient light conditions.

16. Cancel button shall cancel any call on this station and other stations on the same
    Room Controller that are programmed for remote cancel.

17. Support for up to 3 levels of call-in per patient (Normal, Personal Attention, and
    Priority).
18. Support for up to 4 levels of service required per patient (Green, Orange, Yellow, and Stat).

19. One DIN receptacle (Single Patient) or two DIN receptacles (Dual Patient) providing:
   a. Support for a DIN Pillow Speaker or Call Cord.
   b. Tilt release design to eliminate receptacle damage when the pillow speaker/call cord is pulled from any angle.
   c. Station requires no dummy plugs and also includes a configurable option to require dummy plugs if so desired.
   d. Cord out call if pillow speaker or call cord is inadvertently removed.
   e. Ability to program the call priority level on a per patient/bed basis for a Dual Patient Station.

20. Unit shall mount in a standard UL recognized 2-gang or 3-gang electrical box.

21. Optional features:
   a. One ¼ inch receptacle (Single Patient) or two ¼ inch receptacles (Dual Patient) for use with ¼ inch call cords or for auxiliary alarm input.
   b. Support for up to three (3) additional levels of call-in per Pillow Speaker providing a total of four (4) levels of call-in.
   c. Muting of entertainment audio over DIN pillow speaker when intercom is in use.
   d. Full duplex audio to the Enhanced DIN pillow speaker.
   e. Built-in lighting control isolation.
   f. Feature bed (Stryker, Hill-Rom) support including call-in, entertainment and light control, bed unplugged indicator, and bed exit alarm; one connection per bed for feature beds.
   g. Two programmable feature buttons with field customizable labels. Default operation of feature buttons shall be Code Blue and Staff Emergency.
   h. Ability to set privacy mode at the station. Privacy mode prevents staff from calling into the room and listening to the patient while calls initiated from the room still support a two way audio connection.
   i. Ability to place a Routine call from a button on the front of the station.

E. Pull-Cord Intercom or Bath Intercom Stations, Provide as shown on plans. Each station shall provide the following:

   1. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Staff Terminal.
2. Momentary action call button with the ability to place the same or different call priority than the pull cord, momentary action Cancel button, monitor LED indicator, and call-placed LED indicator.

3. Six (6) foot, cut-to-length, PVC pull-cord for call placement with plastic cord guide and large easy to pull plastic "bell" attached.

4. Call from station may be configured to be canceled remotely from Nurse Console, Staff Terminal, remotely within the same room, or only from the originating station.

5. Blue LED to illuminate the station in low ambient light conditions.

6. Unit shall mount in a standard UL recognized 2-gang electrical box.

F. Staff Stations. Provide as shown on plans. Each station shall provide the following:

1. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Staff Terminal.

2. Momentary action call button, cancel button, monitor LED indicator, and call-placed LED indicator.

3. Cancel button shall cancel any call on this station and other stations in the same room that are programmed for remote cancel.

4. Blue LED to illuminate the station in low ambient light conditions.

5. Unit shall mount in a standard UL recognized 2-gang electrical box.

G. Duty Stations. Provide as shown on plans. Each station shall provide the following:

1. Full duplex audio utilizing a 2 ¾ inch oval speaker and a separate microphone with talk/listen volume set on a Station by Station basis at any Nurse Console or Staff Terminal.

2. Four (4) LED call status indicators with 180° visibility to annunciate calls grouped into one of four main categories: routine, urgent, emergency, code. Customized call tones match tones at Nurse Console with an adjustable day/night tone level.

3. Momentary action call button with call placed LED indicator, monitor LED indicator, and momentary action Cancel/Tone Silence button. When call tone is temporarily silenced, the tones regenerate with a subsequent call annunciation to the respective Duty Station.
4. Blue LED to illuminate the station in low ambient light conditions.
5. Unit shall mount in a standard UL recognized 2-gang electrical box.

H. Visual Duty Stations, Provide as shown on plans. Each station shall provide the following:
1. Four (4) LED call status indicators to annunciate calls grouped into one of four main categories: routine, urgent, emergency, code. Customized call tones match tones at Nurse Console with an adjustable day/night tone level.
2. Momentary action tone silence button. When call tone is temporarily silenced, the tones regenerate with a subsequent call annunciation to the respective Duty Station.
3. Blue LED to illuminate the station in low ambient light conditions.
4. Unit shall mount in a standard UL recognized 1-gang electrical box.

I. Room Controllers, Provide as shown on plans. Each Room Controller shall provide the following:
1. Provides power, data, audio and control for up to fifteen (15) Room Stations (intercom and peripheral) within a specific room or area.
2. Unit shall mount in a standard UL recognized 2-gang electrical box.

J. Room Controllers with integrated Dome Light
Provide as shown on plans. Each Dome Light shall provide the following:
1. Provides power, data, audio and control for up to fifteen (15) Room Stations (intercom and peripheral) within a specific room or area.
2. Indicate the highest level call priority within a specific room or area using maintenance free LED indicators of the following colors: white and red. Depending on the call priority the indicators can light solid or flash.
3. A translucent lens and four section with opaque partitions separating the sections.
4. Dome Light housing and lens resist damage by common hospital cleaning agents.
5. Continuous supervision of the Dome Light and Room Stations. In the unexpected event of communications loss with the Nurse Call Gateway, the Dome Light enters a local room failsafe mode and continues to visually indicate local calls.
6. Unit shall mount in a standard UL recognized 1-gang or 2-gang electrical box.
7. Optional features:
a. Six (6) color Dome Lights: Indicate the highest level call priority or service requirement within a specific room or area using maintenance free LED indicators of the following colors: white, red, amber, green, orange, and blue.

b. Multi-color Dome Lights:
   1) Indicate the highest level call priority or service requirement within a specific room or area using maintenance free LED indicators capable of producing a minimum of the following eight (8) colors in over forty (40) color/pattern combinations: white, red, yellow, orange, green, blue, magenta and pink and to be displayed with five (5) light patterns: steady, slow flash, fast flash, sequence slow, and sequence fast.
   2) The ability, for semi-private rooms, to uniquely indicate calls from each of the two beds.
   3) Simultaneously indicate up to three levels of staff presence at the same time: Green, Orange, and Amber.

K. Zone Lights
   Provide as shown on plans. Each Zone Light shall provide the following:
   1. Programmable to indicate the highest level call within zone light areas using maintenance free LED indicators of the following colors: white and red. Depending on the call priority the indicators can light solid or flash.
   2. A translucent lens and four section with opaque partitions separating the sections.
   3. Dome Light housing and lens resist damage from common hospital cleaning agents.
   4. Unit shall mount in a standard UL recognized 1-gang or 2-gang electrical box.
   5. Optional features:
      a. Six (6) color Zone Lights: maintenance free LED indicators of the following colors: white, red, amber, green, orange, and blue.
      b. Multi-color Zone Lights: maintenance free LED indicators capable of producing a minimum of the following 8 colors in over 40 color/pattern combinations: white, red, yellow, orange, green, blue, magenta and pink and to be displayed with five light patterns: steady, slow flash, fast flash, sequence slow, and sequence fast.

L. Peripheral Stations
   Provide as shown on plans the following peripheral stations associated with Room Controllers. Each Peripheral Station shall provide the following:
1. A momentary cancel button to both cancel calls from the station itself and the ability to remote cancel calls on other stations associated with the same Room Controller.

2. LED indicator associated with any button or jack that places a call, initiates a procedure, or registers a staff member.

3. Full duplex audio through associated intercom station associated with the same Room Controller.

4. Include a blue LED to illuminate the station in low ambient light conditions.

5. Mount in a UL recognized 1-gang electrical box.

6. Individual Peripheral Stations shall be:
   a. Single Level Pushbutton Station:
      1) Momentary call button with customizable call priority label insert.
   b. Single Level Large Pushbutton Station:
      1) Momentary call button preconfigured as “Code Blue or “Code Pink”.
      2) Elapsed timer output to start a count up timer on any clock that accepts a remote timer input.
   c. Pull-Cord Pushbutton Emergency Station:
      1) Six (6) foot, cut-to-length, PVC pull-cord with plastic cord guide and large easy to pull plastic “bell” attached.
      2) Momentary action call button with the ability to place the same or different call priority than the pull cord.
   d. Pull-Cord Pushbutton Emergency Shower Station:
      1) Six (6) foot, cut-to-length, PVC pull-cord with plastic cord guide and large easy to pull plastic “bell” attached.
      2) Momentary action call button with the ability to place the same or different call priority than the pull cord.
      3) Wall gasket and waterproof design allowing direct application of water spray from a shower stall or similar type installation.
   e. Dual Level Pushbutton Station:
      1) Two (2) momentary action call buttons each with a different call priority and the ability to customize the call priority and associated label insert. Default call priorities are Emergency and Code.
   f. Staff Registration Station:
      1) Three (3) individually latching buttons supporting three (3) levels of staff presence: Green, Orange, and Amber.
   g. Auxiliary Alarm Input Station:

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1) Two (2) 1/4 inch jacks for the connection of external patient monitoring devices:
   a) Individually programmable call priority level per jack each with a customizable call priority label insert.
   b) Ability to associate multiple Auxiliary Alarm Input Stations with the same room controller in turn supporting up to a total of thirty (30) unique alarm input call priorities.
   c) Configurable for latching or non-latching inputs.
   d) No dummy plugs required.

h. Procedure Station
   1) Four (4) buttons with the ability to customize each button and the associated label insert for the following types of functionality:
      a) Staff registration
      b) Remote cancel
      c) Call placement
      d) Event initiation

   2) Default housekeeping configuration with buttons for:
      a) Transport
      b) Cleaning Needed
      c) Cleaning in Progress
      d) Bed Ready

i. Remote Cancel Station:
   1) A momentary cancel button to remote cancel calls on other stations associated with the same Room Controller.

M. Pillow Speakers

7. Provide one (1) Pillow Speaker per Single Patient Station and two (2) Pillow Speakers per Dual Patient Station with an additional 5% as spares. Each Pillow Speaker shall provide:
   a. Molded ABS plastic case and controls.
   b. An integral grill with speaker/microphone.
   c. Nurse call button.
   d. Ten (10) foot vinyl-insulated cord with electrostatic discharge protection and molded strain relief at each end.
   e. Spring-type metal bed clip.
   f. Molded plastic plug with 8-pin DIN connector.
   g. Optional features:
1) Two (2) auxiliary buttons for control of in-room lighting or other in-room devices.

h. There shall be three different pillow speaker models available (specification writer choose one model below):
   1) Standard:
      a) TV channel up and down buttons.
      b) TV volume up, volume down, and mute buttons.
      c) TV power button.
      d) TV closed caption button.
   2) Direct Access:
      a) TV channel 10-digit direct access buttons.
      b) TV channel up and down buttons.
      c) TV volume up, volume down, and mute buttons.
      d) TV power button.
      e) TV closed caption button.
   3) Enhanced:
      a) Four call-in buttons with associated LED call placed indicators: “nurse”, “pain”, “water”, and “toilet”.
      b) Full duplex audio to the pillow speaker via built-in microphone and separate speaker.
      c) Night light to illuminate the pillow speaker in low ambient light conditions.
      d) TV channel 10-digit direct access buttons.
      e) TV channel up and down buttons.
      f) TV volume up, volume down, and mute buttons.
      g) TV power button.
      h) TV closed caption button.
      i) Two (2) auxiliary buttons for control of in-room lighting or other in-room devices.

N. Feature Bed Receptacles
   Provide as shown on plans one (1) Feature Bed Receptacle per Single Patient Station and two (2) Feature Bed Receptacles per Dual Patient Station. Feature Bed Receptacle shall provide:
   1. Simple means to connect Feature Bed to Patient Station.
   2. Capable of providing the following (depending on the functionality included with the bed siderail):

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a. TV: Channel Up, Channel Down, Volume, On/Off.

b. Up Light on/off.

c. Down Light on/off.

d. Bed Exit.

e. Entertainment muting during intercom with transfer of intercom audio to bed siderails.

3. Supervision of bed connection

a. Alarm call through Patient Station if bed is disconnected.

b. Inserting dummy plug, tethered to Bed Receptacle, cancels Alarm Call.

O. Call Cords

Provide Standard and Specialty Call Cords as required:

1. Standard Call Cord:
   a. Ten (10) foot vinyl jacketed cord.
   b. Thermoplastic pendant with momentary contact nurse call pushbutton.
   c. 8-pin DIN connector.
   d. Metal bed clip.
   e. Strain relief at both ends.

2. Sealed Call Cord:
   a. Ten (10) foot vinyl jacketed cord.
   b. Thermoplastic pendant with sealed momentary contact nurse call pushbutton.
   c. Night light to illuminate the call cord pendant in low ambient light conditions.
   d. 8-pin DIN connector.
   e. Metal bed clip.
   f. Strain relief at both ends.

3. Specialty Geriatric Call Cord:
   b. 8-pin DIN connector.
   c. Metal bed clip.

4. Specialty Breath Activated Call Cord:
   a. Conduit: Plastic covered, three (3) foot heavy-duty flexible metal conduit.
   b. Straw: 2 inch x 5/16 inch diameter clear vinyl straw (12 provided).
   c. Cord: 9 foot x 5/16 inch diameter grey plastic tubing.
   d. Connector: 1/4 inch phone-type plug.
P. Reporting Software Package – optional
   Reporting Software Package providing the following:
   1. Support computer archiving and analysis of patient call activity and staff response for entire Nurse Call Communications Network onto a single logging PC.
   3. Remote report generation capability from any networked PC work station on the facility’s LAN.
   4. Ability to export data to Crystal Reports for enhanced analysis.

Q. Pocket Page Interface – optional
   Pocket Page Interface providing the following:
   1. Using industry standard TAP protocol to transmit informational messages and patient call information to the facility’s pocket page encoder/transmitter.
   2. Call notification/display to the caregiver’s pocket pager includes calling room, bed, call priority, and optional “tag” message.
   3. Supporting three programmable operating modes for each hospital unit/ward. Regardless of the mode of operation, all calls will continue to annunciate at respective Duty Stations, Nurse Consoles, and Staff Terminals:
      a. Manual Mode – from a Nurse Console or Staff Terminal, staff members can manually initiate a message to any caregiver’s pocket pager.
      b. Automatic Mode – always route patient calls from patients to their assigned caregiver’s pocket pager.
      c. Semi-Automatic – from a Nurse Console or Staff Terminal staff members selectively initiate pocket page notification to assigned caregivers by setting a service requirement. As part of the service requirement the staff member may include an informational “tag” message detailing patient’s needs.
   4. If a call is not cleared within a preprogrammed time period the pocket page message will automatically route to the next assigned staff member’s pager.
   5. Over any PC on the facility’s LAN support:
      a. The ability to assign of up to three caregivers for each patient for up to three shifts within a 24 hour period.
b. Customize which call priorities route first, second, or third to each of the assigned caregivers.

c. Create multiple crash teams and group notifications based on specific call priorities and/or units. Group/crash team pages will automatically display on all pocket pagers for caregivers assigned to that group/crash team.

6. Patients without an assigned caregiver shall automatically route to a unit-wide backup pocket pager to ensure no patient call is missed.

7. Notification of system errors automatically sent to a designated technician’s pocket pager.

R. Facility-Wide Wireless Phone Interface – optional

Wireless Phone Interface providing the following:

1. Call notification and display to caregiver’s wireless phone includes calling room, bed, call priority, and optional “tag” message. Upon notification of a call, from the wireless phone the caregiver can:
   a. Use a single key press to connect the caregiver with the calling patient through the Patient Station in the room.
   b. Set a service requirement (Green, Orange, Amber, or Stat) for the calling patient to direct the call to other caregiver’s assigned to this same patient. As part of the service requirement the staff member may include informational “tag” message detailing patient’s needs.

2. Ability to dial directly to patient rooms and staff areas to communicate over the associated Patient, Staff, or Duty Station.

3. Support for three programmable operating modes for each hospital unit/ward. Regardless of the mode of operation, all calls will continue to annunciate at respective Duty Stations, Nurse Consoles, and Staff Terminals:
   a. Manual Mode – from a Nurse Console or Staff Terminal, staff members can manually initiate a text message to any caregiver’s wireless phone.
   b. Automatic Mode – always route patient calls from patients to their assigned caregiver’s wireless phone.
   c. Semi-Automatic – from a Nurse Console or Staff Terminal staff members selectively initiates wireless phone notification to assigned caregivers by setting a service requirement. As part of the service requirement the staff member may include an informational “tag” message detailing patient’s needs.
4. If a patient call is not cleared within a preprogrammed time period the call notification will automatically route to the next assigned staff member’s wireless phone.

5. Over any PC on the facility’s LAN support:
   a. The ability to assign up to three caregivers for each patient for up to three shifts within a 24 hour period.
   b. Customize which call priorities route first, second, or third to each of the assigned caregivers.
   c. Create multiple crash teams and group notifications based on specific call priorities and/or units. Group/crash team notifications will automatically display on all wireless phones for caregivers assigned to that group/crash team.

6. Patients without an assigned caregiver shall automatically route to a unit-wide backup wireless phone to ensure no patient call is missed.

S. RTLS (Real Time Locating System) Interface – optional
   RTLS Interface providing the following
   1. System is capable of integrating to infrared (IR) technology for precise identification and location of caregivers throughout the facility. The caregiver’s name and level (Green, Orange, Amber) is displayed on the Nurse Consoles and Staff Terminals.
   2. RTLS Staff locating supports all staff registration features at the Nurse Console and patient room including:
      a. Ability to locate caregivers closest to a calling room.
      b. Ability to selectively forward call tones to locations where caregivers are located.
      c. Ability to automatically forward Code Blue level call tones to caregiver’s locations.
      d. Ability to manually forward call-in tones to up to ten (10) rooms.
      e. Upon registering into the room, any outstanding Service Requirements matching the staff level or any outstanding patient calls from the Patient Station, configured for remote cancel, will be automatically cleared.
      f. Indication at the Dome Light of staff present within the respective patient room.

T. ADT Interface – optional
   Provide an HL-7 compliant interface (V2.2 – 2.5) to receive relevant patient information from the ADT system with the following functionality:
1. Mapping of standard ADT segment field components and subcomponents to nurse call fields.

2. Display of patient information at Nurse Consoles and Staff Terminals when a patient call is annunciated, when a patient call is answered, or when a patient room is dialed directly.

3. All updates shall be real time, but software shall buffer data for any interruption of service.

END OF SECTION 275223
FIRE ALARM (CUMC)
SECTION 283111 – FIRE ALARM (CUMC)

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes an Individually Coded IFA with Voice. Provide coded alarm tone signaling using sounding devices to sound the alarm evacuation, and strobe lights, including firemen's HVAC override control panel. The system shall be analog addressable, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards.

B. The work covered by this Section of the Specification shall include all labor, equipment, materials and services to furnish and install a complete fire alarm system of the addressable, non-coded type. It shall be complete with all necessary hardware, software and memory specifically tailored for this installation. It shall be possible to permanently modify the software on site by using a plug-in programmer. The system shall consist of, but not be limited to, the following:

1. Fire Command Center and related remote data gathering panels.
2. Remote Annunciators with semi flush backbox.
3. Addressable manual fire alarm stations.
4. Addressable analog area smoke detectors.
5. Addressable analog duct smoke detectors.
6. Addressable analog heat detectors.
7. Audible notification appliances - speakers.
9. Air handling systems control and monitoring.
10. Sprinkler systems control and monitoring.
11. Generator systems monitoring.
12. Elevator systems control.
13. Door release systems control.
15. Normal and battery power supplies.
16. Central station reporting.

C. Prior to the commencement of work, obtain all permits necessary for installation of the work. All permit costs and inspections fees shall be included as part of the required work. After completion of work, notify all authorities having jurisdiction.
D. Local requirements shall be adhered to with regard to submitting specifications, wiring diagrams, shop drawings and plans. Responsibility for furnishing the quantities of copies, as directed by such requirements, shall be included as part of the work of this Section.

E. Submit a letter of approval of the installation, from the local code authority, before requesting final acceptance of the system.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.

B. Installer Qualifications: An experienced installer who is an authorized representative of the manufacturer for both installation and maintenance of units required for this Project.

C. Source Limitations: Obtain fire alarm system components through one source from a single manufacturer.

D. Comply with the 2014 New York City Fire Code including applicable standards NFPA 13, 13D, 13R, 14, 20, and 72 modified for New York City in accordance with Appendix-Q and in concert with applicable Chapters of the 2014 New York City Construction Code.

E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC, including Article 760, and in concert applicable Chapters of the 2014 New York City Construction Code.

F. Comply with the New York City Mechanical Code in concert with applicable Chapters of the 2014 New York City Construction Code.

G. Comply with the rules, regulations, and requirements of the Fire Department of the City of New York in concert with the New York City Department of Buildings.

H. Comply with all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.

I. Fire alarm system shall be UL listed.

J. Submit three copies of all required Licenses and Bonds.
1.3 FACILITY OPERATIONS REQUIREMENTS

A. The system shall be installed and fully tested under the supervision of a trained manufacturer’s representative. The system shall be demonstrated to perform all of the function as specified.

B. The installing contractor or fire alarm equipment vendor shall have no less than two (2) NICET Level II fire alarm technicians dedicated to this project.

C. The Installing Contract and the Fire Alarm System Vendor shall, upon the request of the Consulting Engineer or End-User, attend any and all project meetings for the purpose of accurately determining progress.

D. It shall be the responsibility of the installing contractor to assure that construction debris does not adversely affect any sensing devices installed as part of this project. Should it be deemed necessary by the Consulting Engineer, End-User or AHJ, the installing contractor shall be responsible for the cleaning of all smoke detectors prior to final acceptance.

E. The fire alarm system vendor shall test the system in accordance with the manufacturer’s requirements and NFPA 72 as amended by the NYC Building Code. The vendor shall provide completed reports to the Consulting Engineer for review and approval prior to final acceptance.

F. Each individual system operation on a circuit by circuit basis shall be tested for its complete operation. The procedure for testing the entire fire alarm system shall be set forth with the consent of the code enforcement official, the Engineer and the manufacturer.

G. Submit the following Product Data:
   1. Provide list of all types of equipment and components provided. This shall be incorporated as part of a Table of Contents, which will also indicate the manufacturer’s part number, the description of the part, and the part number of the manufacturer’s product datasheet on which the information can be found.
   2. Provide description of operation of the system (Sequence of Operation), similar to that provided in Part 2 of this Section of the Specifications, to include any and all exceptions, variances or substitutions listed at the time of bid. Any such exceptions, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment. The sequence of operation shall be project specific, and shall provide individual sequences for every type of alarm, supervisory, or trouble condition that may occur as part of normal or off-normal system use.
3. Provide manufacturer’s printed product data, catalog cuts and description of any special installation procedures. Poorly photocopied and/or illegible product data sheets shall not be acceptable and shall be rejected. All product datasheets shall be highlighted or stamped with arrows to indicate the specific components being submitted for approval.

4. Provide manufacturer’s installation instruction manual for specified system.

5. Provide shop drawings as follows:
   a. Coversheet with project name, address and drawing index.
   b. General notes drawing with peripheral device backbox size information, part numbers, device mounting height information, and the names, addresses, point of contact, and telephone numbers of all contract project team members.
   c. Device riser diagram that individually depicts all control panels, annunciators, addressable devices, and notification appliances. Shall include a specific, proposed point descriptor above each addressable device. Shall include a specific, discrete point address that shall correspond to addresses depicted on the device layout floor plans. Drawing shall provide wire specifications, and wire tags shown on all conductors depicted on the riser diagram. All circuits shall have designations that shall correspond with those require on the control panel and floor plan drawings. End-of-line resistors (and values) shall be depicted.
   d. Control panel termination drawing(s). Shall depict internal component placement and all internal and field termination points. Drawing shall provide a detail indicating where conduit penetrations shall be made, so as to avoid conflicts with internally mounted batteries. For each additional data gathering panel, a separate control panel drawing shall be provided, which clearly indicated the designation, service and location of the control enclosure. End-of-line resistors (and values) shall be depicted.
   e. Device typical wiring diagram drawing(s) shall be provided which depict all system components, and their respective field wiring termination points. Wire type, gauge, and jacket shall also be indicated. When an addressable module is used in multiple configurations for monitoring or controlling various types of equipment, different device typical diagrams shall be provided. End-of-line resistors (and values) shall be depicted.
   f. Device layout floor plans shall be created for every area served by the fire alarm system. CAD Files (AutoCAD – latest edition) shall be provided by the consulting engineer for the fire alarm system equipment vendor in the preparation of the floor plans. Floor plans shall indicate accurate locations for all control and
peripheral devices. Drawings shall be NO LESS THAN 1/8 INCH SCALE. All addressable devices shall be depicted with a discrete address that corresponds with that indicated on the Riser Diagram. All notification appliances shall also be provided with a circuit address that corresponds to that depicted on the Riser Diagram. If individual floors need to be segmented to accommodate the 1/8” scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner. End-of-line resistors (and values) shall be depicted.

g. Contained in the title block of each drawing shall be symbol legends with device counts, wire tag legends, circuit schedules for all addressable and notification appliance circuits, the project name/address, and a drawing description which corresponds to that indicated in the drawing index on the coversheet drawing. A section of each drawing title block shall be reserved for revision numbers and notes. The initial submission shall be Revision 0, with Revision A, B, or C as project modifications require.

6. Battery calculations shall be provided on a per power supply/charger basis based on 24 hours of supervision and 45 minutes of alarm. These calculations shall clearly indicate the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, totals for all categories, and the calculated battery requirements. Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws. Failure to provide these calculations shall be grounds for the complete rejection of the submittal package.

H. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance or approval by AHJ. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:

AKF
1. Edwards EST by UTC Fire and Security.

2.2 CIRCUITING GUIDELINES

A. Each Signaling Line Circuit (SLC) shall be circuited so device loading is not to exceed 80% of loop capacity in order to leave for space for future devices. The loop shall have Class B operation. Each DGP shall include an SLC loop on a per floor basis. T-Tapping a selected loop to cover an alternate floor shall not be accepted.

B. NAC Circuits shall have Class B operation. Each of the following types of alarm notification appliances shall be circuited as shown on the drawings but shall be typically as follows:
   1. Audible Signals: Provide sufficient spare capacity to assure that the addition of five (5) audible devices can be supported without the need for addition control components (power supplies, signal circuit modules, amplifiers, batteries, etc.)
   2. Visual Signals: Provide sufficient spare capacity to assure that the addition of three (3) visual devices can be supported without the need for addition control components (power supplies, signal circuit modules, batteries, etc.)

C. The network riser shall be wired NFPA Style 7 (Class A with isolation).

D. Where it is necessary to interface conventional initiating devices provide intelligent input modules to supervise Class B zone wiring.

E. Each of the following types of devices or equipment shall be provided with supervised circuits as shown on the drawings but shall be typically as follows:
   1. Sprinkler Valve Supervisory Switches: Provide one (1) supervisory module circuit for each sprinkler valve supervisory switch.
   2. When waterflow and tamper switches exist at the same location, provide one (1) dual input addressable module. When odd numbers of devices exist at a single location, provide additional single input addressable modules.

F. Each of the following types of remote equipment associated with the fire alarm system shall be provided with a form ‘C’ control relay contact and monitor point for status indication, but shall be typically as follows:
   1. HVAC Fan Systems: Provide one (1) shutdown control relay contact and monitor point for status indication for each HVAC fan system.
   2. HVAC Supply Fans: Provide one (1) shutdown control relay contact and monitor point for status indication for each HVAC supply fan.
3. HVAC Return Fans: Provide one (1) shutdown control relay contact and monitor point for status indication for each HVAC return fan.

G. Provide a dedicated 24VDC circuit to feed all auxiliary relays required for inductive loads. Circuits shall be supervised via an end-of-line relay and addressable input module. Auxiliary relays shall not derive their power from the starter or load being controlled.

H. Each control or data gathering panel shall have a dedicated minimum 20Amp-120VAC feed. An appropriate fuse cut out shall be included, wired as indicated in the Electrical Code for the City of NY.

I. In no case shall any fire alarm circuit be sized beyond 80% of circuit capacity

2.3 SUPPORT FOR INSTALLER AND OWNER MAINTENANCE

A. Provide a coded one-man walk test feature. Allow audible or silent testing. Signal alarms and troubles during test. Allow receipt of alarms and programmed operations for alarms from areas not under test.

B. Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.

C. Provide loop controller diagnostics to identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground conditions. Ground faults on the circuit wiring of remote module shall be identified by device address.

D. Allow the user to display/report the condition of addressable analog detectors. Include device address, device type, percent obscuration, and maintenance indicator. The maintenance indicator shall provide the user with a measure of contamination of a device upon which cleaning decisions can confidently be made.

E. Allow the user to report history for alarm, supervisory, monitor, trouble, smoke verification, watchdog, and restore activity. Include Facility Name, Licensee, Project Program Compilation date, Compiler Version, Project Revision Number, and the time and date of the History Report.

F. Allow the user to disable/enable devices, zones, actions, timers and sequences. Protect the disable function with a password.
G. Allow the user to activate/restore outputs, actions, sequences, and simulate detector smoke levels.

H. Allow the service user to enter time and date, reconfigure an external port for download programming, initiate auto programming and change passwords. Protect these functions with a password.

I. THE END-USER SHALL RETAIN COMPLETE RIGHTS AND OWNERSHIP TO ALL SOFTWARE RUNNING IN THE SYSTEM. The fire alarm equipment vendor shall provide useable hard and soft copies of the software database to the End-User at the end of the warranty period. The database provided shall be useable by any authorized and certified distributor of the product line, and shall include all applicable passwords necessary for total and unrestricted use and modification of the database. The Consulting Engineer shall define the extent of hardcopy database documentation to be provided.

2.4 UL LISTED AND APPROVED EQUIPMENT
A. Fire Command Station/ Fire Alarm Control Panel Requirements: The fire alarm control panel or panels and all system devices (speaker-strobes, strobes, pull stations, smoke and heat detectors, etc. shall be Edwards Systems Technology (EST) (formerly GE Security) type EST3 series. All under one label “UL listed and approved” for the use of fire alarm systems in this area of the United States of America. The operating controls shall be located behind locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified.

B. System Controllers: The main controller 3-CPU shall be supervised, site programmable, and of modular design supporting up to 125 detectors and 125 remote modules per addressable Signaling line Circuit (SLC). The CPU shall support up to 10 SLC’s per panel for a total system capacity of 2500 Intelligent Addressable points. The system shall be designed with peer-to-peer networking capability for enhanced survivability, with support for up to 64 nodes, each with up to 2500 points and an overall capacity of 160,000 points. The cabinets shall be steel.

C. The system shall store all basic system functionality and job specific data in non-volatile memory. All site specific and operating data shall survive a complete power failure intact. Passwords shall protect any changes to system operations.

D. The Main Controller Module shall control and monitor all local or remote peripherals. It shall support a large 960 character LCD, power supply, remote LCD and zone display annunciators, printers, and support communication interface standard protocol (CSI) devices such as
color computer annunciators and color graphic displays. Remote LCD annunciators shall also
display each and every point in the system and be sized with the same number of characters
as in the main FACP display.

E. The panel shall have an interface module for remote site monitoring. The control panel shall
include built-in (part of the fire alarm control panel) Digital Alarm Communicator Transmitter
(DACT) module to transmit smoke, supervisory, waterflow, trouble, CO Alarm (if included),
pump running, and pump trouble events to a Central monitoring Station (CMS) company. The
DACT shall support dual telephones lines, 4/2 format communications, and configured for
dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power fail-
ure reports, auto test call, and be site programmable. The DACT shall be capable of transmit-
ting every individual condition to the central station via 4/2 format. Selection of 4/2 format
shall be of the discretion of the engineer and building owner but shall be an available option.
Contractors who choose a separate dialer must meet all of the above options and are respon-
sible for all necessary added connections such as power (with FCO/FDS), conduit, wire, ad-
dressable interface modules etc.

F. The system shall have built-in automatic system programming to automatically address and map
all system devices attached to the main controller. A minimum default single stage alarm sys-
tem operation shall be supported with alarm silence, event silence, drill, lamp test, and reset
common controls.

G. Advanced Windows-based System Definition Utility with Program Version Reporting to docu-
ment any and all changes made during system start-up or system commissioning shall be used
to maintain site specific programming. Time and Date Stamps of all modifications made to the
program must be included to allow full retention of all previous program version data. It shall
support programming of any input point to any output point. The system shall support the use
of Bar Code readers to assist custom programming functions. It shall allow authorized custom-
ization of fundamental system operations using initiating events to start actions, timers, se-
quences and logical algorithms. The system program shall meet the requirements of this pro-
ject, current codes and standards, and satisfy the local Authority Having Jurisdiction.

H. The system shall support distributed processor intelligent detectors with the following operation-
al attributes; integral multiple differential sensors, automatic device mapping, electronic ad-
dressing, environmental compensation, pre-alarm, dirty detector identification, automatic
day/night sensitivity adjustment, normal/alarm LEDs, relay bases, sounder bases and isolator
bases.
I. The system shall use full digital communications to supervise all addressable loop devices for placement, correct location, and operation. It shall allow swapping of “same type” devices without the need of addressing and impose the “location” parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.

J. Each controller shall contain a RS232 printer/programming port for programming locally via an IBM PC. When operational, each controller shall support a printer through the RS232 port and be capable of message routing.

K. Single stage operation shall be provided.

L. The system shall have a UL Listed Detector Sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4 hours.

M. The system shall support 100% of all remote devices in alarm and provide support for a 100% compliment of detector isolator bases.

N. All panel modules shall be supervised for placement and return trouble if damaged or removed.

O. The system shall have a CPU watchdog circuit to initiate trouble should the CPU fail.

P. The Fire Alarm / Life Safety System shall incorporate a true digital integrated audio system into the network, multiplexing 8 independent audio channels over a single pair of wires. The system shall include distributed audio amplifiers, one for each speaker circuit, and split A/B speaker circuits for the ultimate in system survivability. The system shall provide a local temporal back up tone at each amplifier to allow evacuation signals to be broadcast in the protected premises in the event of a loss of data communication from the multiplexed audio riser. A digital message unit shall be provided which provides up to 32 minutes of pre-recorded emergency messaging. The message contained in the fully digital message unit shall be recordable in the field on a computer.

Q. Audio Source Unit (3-ASU): The Fire Alarm / Life Safety System shall be provided with a fully integrated Emergency Communications System. The Emergency Communications System shall include a paging microphone, digital message playback unit, and 8 fully digitized and multiplexed Audio Channels. Four dedicated page mode control switches shall provide the emergency operator with instantaneous one touch paging to safely control the staged evacuation of building occupants. Automatic programming shall dynamically group the most frequently tar-
The "All Call" switch will direct the manual page to the entire facility. The "Individual Floor" switch will direct the manual page to the certain floor. The "All Call Minus" switch will direct the manual page to those building areas which are programmed to receive the auxiliary and general channel connections such as stairwells. The system shall have paging control switches and LEDs to support specific zone selection as shown on the plans and on by floor basis. The zone control / displays shall confirm amplifier selection and annunciator amplifier and amplifier circuit trouble. The system shall automatically deliver a preannounce tone of 1000 Hz for three seconds when the emergency operator presses the microphone talk key. A ‘ready to page’ LED shall flash during the preannounce and turn steady when the system is ready for the user’s page delivery. The system shall include a page deactivation timer, which activates for 3 seconds when the emergency user releases the microphone talk key. Should the user subsequently press the microphone key during the deactivation period a page can be delivered immediately. Should the timer complete its cycle the system shall automatically restore emergency signaling and any subsequent paging will be preceded by the pre-announce tone.

R. Audio Amplifiers: Each audio power amplifier shall have integral audio signal de-multiplexers, allowing the amplifier to select any one of eight digitized audio channels. The channel selection shall be directed by the system software. Up to 8 multiple and different audio signals must be able to be broadcast simultaneously from the same system network node. Each amplifier output shall include a dedicated, supervised 25/70 Vrms speaker circuit that is suitable for connection of emergency speaker appliances. Each amplifier shall also include a notification appliance circuit rated at 24Vdc @ 3.5A for connection of visible (strobe) appliances. This circuit shall be fully programmable and it shall be possible to define the circuit for the support of audible, visible, or ancillary devices. Standby Audio amplifiers shall be provided that automatically sense the failure of a primary amplifier, and automatically program themselves to select and de-multiplex the same audio information channel of the failed primary amplifier, and fully replace the function of the failed amplifier. In the event of a total loss of audio data communications, all amplifiers will default to the local “EVAC” tone generator channel. If the local panel has an alarm condition, then all amplifiers will sound the EVAC signal on their connected speaker circuits. In the event of a loss of the fully digitized, multiplexed audio riser, the audio amplifiers shall automatically default to an internally generated alarm tone which shall be operated at a 3-3-3 temporal pattern. Audio amplifiers shall automatically detect a short circuit condition on the connected speaker circuit wiring, and shall inhibit itself from driving into that short circuit condition.

S. Fire Fighters’ Telephone Communication System: The Fire and Life Safety System shall include a fully integrated UL864 listed Fire Fighters’ Telephone Communication System as part of the Fire Command Station (FCS). The Fire Fighter’s Telephone Communications System shall in-
clude a Master Telephone handset that provides a totally independent 2-way communication between the Fire Command Station and remote Warden Telephone Stations and/or Fire Fighter Telephone Jacks (see project plans for locations and type of telephone device). The Fire Fighters’ Telephone system shall include an 8-line 160 character LCD display to show the operator the identity and location of up to 20 waiting calls. Each remote Telephone shall be annunciated and connected independently using a dedicated addressable control module. The LCD will display call-in information in full English language up to 20 characters, without the need for individual LEDs and switches per telephone station. The user shall connect a call by pressing the ‘connect’ switch and support up to a minimum of 5 connected calls simultaneously while also annunciating pending calls. The connection shall be a “conference” or “party Line” call. To terminate a call, the operator shall scroll the display cursor over the connected callers’ ID message, and press the ‘disconnect’ switch. Any Telephone, by means of a manual operation at the FCS, shall be allowed to make an emergency announcement in his/her area, without affecting the simultaneous alarm signals or announcements to any other area or floor in the building. Should the Fire Fighter’s Telephone system for any reason require additional controls and indicators, a selection switch and connection LED for each and every telephone shall be provided so as to provide individual annunciation and control.

T. Audible notification appliances shall be affected by signal silence features. Visual signal appliance shall not be affected by signal silence features.

U. User Interface: The 3-LCDXL Display Module shall be of membrane style construction with a 24 line by 40-character (960 total characters) Liquid Crystal Display (LCD). The LCD shall use super-twist technology and backlighting for high contrast visual clarity and a colored gray/black and white display. In the normal mode the LCD shall display the time, a customer facility name, and the number of history events. In the alarm mode the LCD display the total number of events and the type of event on display. The LCD shall reserve 42 characters of display space for each user custom message by addressable device. The module shall have visual indicators for the following common control functions; Power, Alarm, Supervisory, Monitor, Trouble, Disable, Ground Fault, CPU fail, and Test. There shall be common control keys and visual indicators for reset, alarm silence, panel silence, and drill. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward / backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicators to flash the indicators when undisplayed events are available for display and turn on steady when all events have been displayed. The LCD shall display the first event of the highest priority as well as the previous seven (7) alarm events “hands free” in chronological order so that the arriving firefighter may track the fires progression. Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero through nine with delete and enter keys.
V. Power Supplies: The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 7.0A continuous for notification appliance circuits. The power supply shall be capable of providing 7A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 45 minutes.

W. Auxiliary power supplies shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 7.0A continuous for notification appliance circuits. The power supply shall be capable of providing 7A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 45 minutes.

X. Firefighters Smoke Control System – FSCS.

1. The FSCS shall be utilized for control of both Smoke Control and Post Fire Smoke Purge.
   a. Smoke control shall include Atrium, Stair, Elevator Shaft Smoke Control as well as zoned smoke control per the project plans and NYC Building Code section 909, Chapter 4 and Chapter 10 as well as the NYC Mechanical Code.
   b. Post Fire Smoke Purge shall include post fire smoke evacuation per NYC Building Code section 912.

2. The FSCS shall be integral to the Fire Command Station or Fire Alarm Control Panel. It shall include switch/LED modules that provide three position (on/off/auto and open/closed/auto) switches and 4 LED’s (normal, on, off, fault or normal, open, closed, fault) per each smoke control system controlled as required by NYC Code section 909.16.
   a. The FSCS shall be UL864 and UUKL listed and designed per the NYC Building Code Chapter 9.
   b. The FSCS shall include 3 position switches for each smoke control system. Each switch shall include On/Off/Auto positions for control of smoke control fan systems and Open/Closed/Auto positions for Smoke Control Dampers systems.
   c. The FSCS shall include the following indicators for each smoke control system as required per section 909 of the NYC Building Code:
i. Fans, Dampers, or other operating equipment in their normal status – White Indicator

ii. Fans, Dampers, or other operating equipment in their off or closed position – Red Indicator

iii. Fans, Dampers, or other operating equipment in their on or open Status – Green Indicator

iv. Fans, Dampers, or other operating equipment in Fault - Yellow Indicator

v. Smoke Control switch and LED modules shall include a printable portion next to each switch and LED set for a custom descriptor of each smoke control system. The printable portion shall include text and graphical icons indicating the function of the smoke control system.

vi. Verification All Dampers that are part of the smoke control system shall include verification per section 909 of the NYC Building code and NFPA 92A.

   i. Verification shall mean end switches (true open and true closed) for each smoke control damper.

   ii. All fans used for smoke control shall include verification per section 909 of the NYC Building code and NFPA 92A. Verification shall mean duct pressure, airflow, or equivalent sensors.

   iii. The white normal indicator shall give the FSCS operator a clear indication that the smoke control equipment is operating properly. Dampers that are not open or not closed (mid point) shall extinguish the white indicator.

   e. When a smoke control fan is indexed to start manually or from the fire alarm system all dampers shall open. When fan is indexed to stop, all dampers shall close unless indicated differently on the project plans.

   f. Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Chapter 9 and NFPA 72.

3. The FSCS shall include manual post fire smoke purge per section 912 of the NYC Building Code. Manual smoke purge shall be integral to the FSCS or located on Led/Switch modules directly adjacent to the smoke control controls and indicators. Controls for smoke purge shall only be available after activation of a built in FDNY/NYC approved 2642 key. A 2-position On/Off switch shall be included by floor or area for manual evacuation of smoke. Each 2-position switch shall include a green indicator that displays when the purge fan is on and a yellow trouble indicator. A graphic diagram indicating the portions of the building served by each post fire smoke purge system shall be included.
4. Fans will not be affected upon system reset. Restarting the fans may be accomplished by turning them back on in an individual sequential fashion or through individual manual switches at the FSCS controls to eliminate the possibility of all fans turning on simultaneously.

5. Under normal circumstances, smoke exhaust fans, respective fire-smoke dampers, motorized dampers shall be closed unless noted otherwise on the project plans.

Y. Network alphanumeric annunciators shall be located throughout the facility as indicated on the plans and in the fire safety director’s office or constantly attended location. The system shall have the capacity to support 64 network annunciators or EST3 network panel nodes. Each annunciator shall contain a supervised, back lit, liquid crystal with a minimum of 8 line with 21 characters per line. Where required, the annunciator shall include additional zonal announcement and manual control without additional enclosures. The annunciator shall support full ability to serve as the operating interface to the system and shall include the following features:

1. Matched appearance with other system displays, Each LCD Display on each node (cabinet) in the system shall be configurable to show the status of any or all of the following functions anywhere in the system: Alarm, Supervisory, Trouble, Monitor.
2. It must be possible to have up to 64 network annunciators or EST3 panels on the network.
3. Each annunciator must be capable of supporting custom messages as well as system event annunciation. It must be possible to filter unwanted annunciation of trouble functions on a by point or by geographic area. The annunciators shall be mounted in stand-alone enclosures or integrated into the network panels as indicated on the plans.

2.5 COMPONENTS

A. Intelligent Devices — General: Each remote device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Each device shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller. Each device shall be capable of electronic addressing, either automatically or
application programmed assigned, to support physical/electrical mapping and *supervision by location*. Setting a device’s address by physical means shall not be necessary.

B. **Intelligent Detectors — General:** The System Intelligent Detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by digital filters. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total analog loop response time for detectors changing state shall be 0.5 seconds. Each detector shall have a separate means of displaying communication and alarm status. A green LED shall flash to confirm communication with the analog loop controller. A red LED shall flash to display alarm status. The detector shall be capable of identifying up to 32 diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient “Environmental Thresholds” approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24-hour long term and 4-hour short-term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the “learned” base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour. The intelligent analog detectors shall be suitable for mounting on any Signature Series detector mounting base.

C. **Fixed Temperature/Rate of Rise Heat Detector/Combination Heat and CO Detector, SIGA2-HRS, SIGA2-HCOS:** Provide intelligent combination fixed temperature/rate-of-rise heat
The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate-of-rise alarm point of 15°F (9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications. Where shown on the project plans, include SIGA2-HCOS combination Heat and Carbon Monoxide (CO) detector. The combination Heat and CO device shall report separately to the control panel where a heat condition is considered a fire alarm and a CO condition is a supervisory alarm with separate and unique evacuation sequence.

D. Photoelectric Smoke Detector, SIGA2-PS: Provide intelligent photoelectric smoke detectors SIGA2-PS. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. The photo detector shall be rated for ceiling installation at a minimum of 30 ft (9.1m) centers and be suitable for wall mount applications. The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 5,000 ft/min. (0-25.39 m/sec) without requiring specific duct detector housings or supply tubes. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment: Temperature: 32°F to 120°F (0°C to 49°C), Humidity: 0-93% RH, non-condensing, Elevation: no limit.

E. Addressable Carbon Monoxide (CO) Detector, EST model SIGA2-COS with sounder base (for future additions). Provide intelligent addressable Carbon Monoxide Alarms as required by Chapter 9. The CO detection element shall indicate a trouble condition at the FACP signaling end of life and be field replaceable. The CO detector shall be UL 2075 listed.

F. Standard Detector Mounting Bases, SIGA-SB / SIGA-SB4: Provide standard detector mounting bases SIGA-SB suitable for mounting on North American 1-gang, 3½” or 4”
octagon box and 4” square box. The base shall, contain no electronics, support all Signature Series detector types and have the following minimum requirements: Removal of the respective detector shall not affect communications with other detectors, Terminal connections shall be made on the room side of the base, bases that must be removed to gain access to the terminals shall not be acceptable. The base shall be capable of supporting one (1) Signature Series SIGA-LED Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

G. Audible Detector Mounting Base, SIGA-AB4GT. Where shown on the project plans include detector audible/sounder base model SIGA-AB4GT. The sounder base shall be capable of two tones, Temporal 3 for a fire condition and Temporal 4 for a Carbon monoxide condition. The tones shall be fully programmable and also synchronize the sound with other sounder bases. The system shall be UL2017 listed for dual signaling for this purpose.

H. Duct Detector Housing, SIGA-SD: Provide model SIGA-SD Low profile intelligent addressable DUCT smoke detector as indicated on the project plans. Provide for variations in duct air velocity between 100 and 4,000 feet per minute and include a wide sensitivity range of .79 to 2.46%/ft. Obscuration. Include one Form-C shut down relay rated 2.0 amps @ 30 Vdc and also include slave high contact relays if required. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. The addressable DUCT housing shall be suitable for extreme environments, including a temperature range of –20 to 158 degrees F (-29 to 70 degrees Celsius) and offer a harsh environment gasket option. Provide Remote Alarm LED Indicators SIGA-LED and/or remote test station model SD-TRK as indicated on the project plans.

I. Intelligent Modules — General: It shall be possible to address each Intelligent Signature Series module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Modules requiring EPROM, PROM, ROM changes or DIP switch and/or jumper changes shall not be acceptable. The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment: Temperature: 32°F to 120°F (0°C to 49°C), Humidity: 0-93% RH, non-condensing.
J. Single Input Module, SIGA-CT1 (Waterflow Detectors, Tamper Switches etc.): Provide intelligent single input modules SIGA-CT1. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½” (64mm) deep 1-gang boxes and 1 ½” (38mm) deep 4” square boxes with 1-gang covers. The single input module shall support the following circuit types: Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.), Normally-Open Alarm Delayed Latching (Waterflow Switches), Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.), Normally-Open Active Latching (Supervisory, Tamper Switches).

K. Dual Input Module, SIGA-CT2: Provide intelligent dual input modules SIGA-CT2. The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½” deep 1-gang boxes and 1 ½” (38mm) deep 4” square boxes with 1-gang covers. The dual input module shall support the following circuit types: Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.), Normally-Open Alarm Delayed Latching (Waterflow Switches), Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.), Normally-Open Active Latching (Supervisory, Tamper Switches).

L. Single Input Signal Module, SIGA-CC1: Provide intelligent single input signal modules SIGA-CC1. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own “ring tone”. The module shall be suitable for mounting on North American 2 ½” (64mm) deep 2-gang boxes and 1 ½” (38mm) deep 4” square boxes with 2-gang covers, or European 100mm square boxes. The single input signal module shall support the following operations: Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A).

M. Control Relay Module, SIGA-CR: Provide intelligent control relay modules SIGA-CR. The Control Relay Module shall provide one form “R” dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware. The control relay module shall be suitable for mounting on North American 2 ½” (64mm) deep 1-gang boxes and 1 ½” deep 4” square boxes with 1-gang covers.

N. Manual Pull Station, RGS/Aames Security RMS-1P-KL-P-NYC: Provide intelligent single action fire alarm pull stations as indicated on the project plans. The fire alarm station shall be of metal construction with an internal toggle switch. Finish the station in red with silver
“LIFT & PULL” English lettering. The manual station shall be suitable for mounting on North American 2 ½” (64mm) deep 1-gang boxes and 1 ½” (38mm) deep 4” square boxes with 1-gang covers. The manual stations shall have key lock access. Fire alarm pull stations shall be suitable for temperatures 32°F to 120°F (0°C to 49°C), Humidity: 0-93% RH, non-condensing. Each station shall be monitored by an addressable monitor module SIGA-CT1.

O. Weatherproof Pull Station, RGS/Aames Security RMS-1P-KL-LP-WP-NYC: Provide conventional single action weatherproof manual pull stations as shown on the project plans. The weatherproof fire alarm station shall be of metal construction with an internal toggle switch and weather rated gasket. Finish of the station shall be red with silver “LIFT & PULL” English lettering. The station shall include a weather rated single gang mounting box. The manual stations shall have key lock access. Weatherproof fire alarm manual pull stations shall be suitable for temperatures -30 °F to 150 °F (-35 °C to 66 °C) and 0 to 85% RH, non-condensing. Each station shall be monitored by an addressable monitor module SIGA-CT1 which shall be located in an interior (heated and conditioned) space.

P. Notification Appliances – General: All appliances shall be UL Listed for Fire Protective Service. All strobe appliances or combination appliances with strobes shall be capable of providing the “Equivalent Facilitation” which is allowed under the Americans with Disabilities Act accessibility guidelines (ADA(AG)), and shall be UL 1971, and ULC S526 Listed. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel (NO EXCEPTIONS) specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturers’ instructions. Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from THE CONTROL PANEL MANUFACTURER clearly stating that the control equipment (as submitted) is 100% compatible with the submitted Notification Appliances.

Q. Strobes, G1RF-VM Series: Provide EST Series G1RF-VM series low profile wall mounted strobes at the locations shown on the drawings. Strobes shall provide synchronized flash outputs. Strobe output shall be field selectable as indicated on the drawings in one of the following intensity levels; 15/75, 15cd, 30cd, 75cd or 110cd*. Low profile strobes shall mount in a North American 1-gang box or surface mounted on a matching back box provided by the manufacturer, as directed in the field.* The fire alarm vendor may select below 75 candela where allowed by the appropriate release of ADA. 15/75 strobes may be used in corridors and in locations where 15 candela is required per NFPA wall and ceiling tables (see NFPA 72).
R. Provide speaker/strobes with a 4” cone as manufactured by EST, Cat. No. G4-S7 Series. The rear of the speaker shall be completely sealed protecting the cone during and after installation and screw terminals shall be provided for wiring. Speaker/strobe housings shall be red and include "FIRE" labeling. Speakers shall be provided for use with 70V systems and shall provide power taps at 1/4w, 1/2w, 1w, and 2w. Speaker/strobes shall provide UL confirmed 90 dBA sound output at 2w. Strobes shall provide 15/75, 30, 75 cd 110 candela* synchronized flash outputs. The strobe shall have lens markings oriented for wall mounting. Ceiling mounted Speaker/Strobes shall have lens markings with correctly oriented lettering. Speaker/strobes shall mount in a North American 4” electrical box with extension ring using the 2 screws provided with ring.* The fire alarm vendor may select below 75 candela where allowed by the appropriate release of ADA. 15/75 strobes may be used in corridors and in locations where 15 candela is required per NFPA wall and ceiling tables (see NFPA 72).

S. Weather Rated Strobes, Speakers and Speaker Strobes: Provide EST model WG4RF-SVMC weather rated Notification Appliance Circuit (NAC) devices as indicated on the project plans. Weatherproof NAC devices shall be suitable for temperatures -31 °F to 150 °F and 0 to 95% RH, non-condensing. Weather rated NAC devices shall include a weather resistant color matched mounting box. Speakers shall include multiple taps – 1/4, 1/2, 1 and 2 watts for up to 90 dBA at 10 ft.

T. Multi-Voltage Control Relays, MR-200 Series: Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc. Relay contact ratings shall be DPDT and rated for 10 amperes at 115 Vac. A single relay may be energized from a voltage source of 24 Vdc, 24 Vac, 115 Vac, or 230 Vac. A red LED shall indicate the relay is energized. A metal enclosure shall be provided.

U. Electromagnetic Door Holders: Provide Wall Mounted, EST Edwards 1504/1505/1508/1509 Series. Provide flush, semi-flush or surface wall mounted electromagnetic door holder/releases rated at 24 Vac/Vdc as directed by the Consulting Engineer. Finish shall be brushed zinc. Electromagnetic door holders submitted for use must have written proof of their compatibility for the purposes intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purposes intended.

V. STI Stopper II Lexan Guards: Manual pull stations that are provided with STI Stopper II lexan guards shall include non-audible alarms as required on the plans. They shall be surface or flush mounting, as required for each individual device. Stopper Covers shall only be included on devices shown on the plans to include them.
W. Projected Beam Detector – Single End – Model EST EC-50/100R. The projected beam type smoke detector shall be a 4-wire 12/24 Vdc device monitored by the Fire Alarm control panel through a two circuit SIGA-CT2 monitor module (one zone for alarm and one for trouble). The unit shall be listed to UL 268 and shall consist of an integrated transmitter and receiver. The beam detector shall operate between a range of 15 and 160 feet (4.57 and 48.77 m) or 160 and 330 feet (48.77 and 100 m)(contractor shall determine distance to select appropriate model). It shall feature automatic gain control, which will compensate for gradual signal deterioration due to dirt accumulation on the lenses. The unit shall include a wall mounting bracket. Testing shall be carried out using a calibrated test filter. It shall be possible to test the detector without direct access to it by means of a remotely installed key-operated test station.

X. Fire Fighter Warden Stations: Install NYC warden stations as required by NYC code Appendix Q. Provide NYC/MEA approved warden stations installed for Flush (6830-NYF4) or surface (6830-NYS4) installation as directed by the project engineer. Warden Station shall be NYC MEA approved, painted RED and include armored cable and an in-use LED as required by NYC code. Warden Stations shall be mounted in a manor as indicated on the plans and as required by FDNY. Warden stations shall be located as required by NYC code Chapter 9, at a minimum of in each stairwell on each floor and in elevator lobby on each floor.

Y. Fire alarm equipment shall be powered through an approved Fuse Disconnect Switch (FDS) connected ahead of the main service switch. The FDS shall be heavy duty (200,000 rms short circuit amps) safety switch @30 amps minimum, painted red, include a ground and Neutral kit with grounding screw (to bond neutral), include a padlock with Y1 cylinder keyed to a NYC/FDNY 2642 key (use ABUS re-keyable 83-45 or equivalent lock). All wiring shall be #10 minimum THHN or equivalent run in ¾ inch EMT/RGS and in accordance with NYC requirements. The ground to the FDS shall be made using a NYC accepted method (see NYC electrical code), and the ground wire to the FDS shall be #8 minimum (larger if necessary to meet feed size). The equipment ground leaving from the FDS connecting to the fire alarm equipment shall include a #10 green ground. The FDS panel shall bear an engraved white-core phenolic or bakelite identification nameplate stating in minimum one-quarter inch (1/4") high white letters on a red background “FIRE ALARM FUSED DISCONNECT”.

Z. Where additional circuits are required by the fire alarm system, a Fused Cutout, properly sized shall be included, wired after the FDS. The size of the fuses shall be sized appropriately but be twenty (20) amperes minimum. The fused cut-out panel shall bear an engraved white-core phenolic or bakelite identification nameplate stating in minimum one-quarter inch (1/4")
high white letters on a red background “FIRE ALARM FUSED CUT-OUT”. The neutral shall not be bonded in the Fused cutout”

2.6 FIRE ALARM SYSTEM SEQUENCE OF OPERATION (INDIVIDUALLY CODED IFA)

ACTIVATION OF AN ALARM ON THE FIRE ALARM SYSTEM WILL:

PULL STATIONS
1. SOUND APPROPRIATE 4 ROUNDS OF NON-SILENCABLE INDIVIDUAL CODES THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMNIATE RED LED AT FIRE ALARM CONTROL PANEL.
4. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACCP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD SCREEN.
5. ACTIVATE ALERT SOUNDER AT FACCP.
6. ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM
   • WITH EXCEPTION OF CRITIC CARE UNITS WHICH WILL SHUTDOWN ON ALARM FOR THAT UNIT
7. TRANSMIT AN PULL ALARM POINT TO CENTRAL OFFICE

SMOKE & DUCTS
1. SOUND APPROPRIATE 4 ROUNDS OF (10-1) NON-SILENCABLE CODE THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMNIATE RED LED AT FIRE ALARM CONTROL PANEL.
4. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACCP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD ACTIVATE ALERT SOUNDER AT FACCP
5. ACTIVATE SMOKE ALARM BELL AT FACCP
6. ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM
7. TRANSMIT AN SMOKE ALARM POINT TO CENTRAL OFFICE
8. ACTIVATE ELEVATOR RECALL UPON ACTIVATION OF ELEVATOR LOBBY, EMR SMOKE DETECTORS AND WATERFLOW DEVICES.

HEAT
1. SOUND APPROPRIATE 4 ROUNDS OF (10-3) NON-SILENCABLE CODE THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMINATE RED LED AT FIRE ALARM CONTROL PANEL.
4. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD ACTIVATE ALERT SOUNDER AT FACP
5. ACTIVATE SMOKE ALARM BELL AT FACP
6. ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM
7. TRANSMIT AN SMOKE ALARM POINT TO CENTRAL OFFICE

WATERFLOW
1. SOUND APPROPRIATE 4 ROUNDS OF (10-2) NON-SILENCABLE TEMPORAL CODE THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMINATE RED LED AT FIRE ALARM CONTROL PANEL.
4. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD ACTIVATE ALERT SOUNDER AT FACP
5. ACTIVATE WATER-FLOW ALARM BELL AT FACP
6. ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM
7. TRANSMIT AN WATERFLOW ALARM POINT TO CENTRAL OFFICE
8. ACTIVATE ELEVATOR RECALL UPON ACTIVATION OF ELEVATOR\EMR SMOKE DETECTORS AND WATERFLOW DEVICES.

UPON ANNUNCIATION OF ANY TROUBLE CONDITION, THE FIRE ALARM SYSTEM WILL:
1. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD
2. ACTIVATE TROUBLE SOUNDER ON FACP.
3. ILLUMINATE YELLOW LED AT FIRE ALARM CONTROL PANEL.
4. ACTIVATE 6” TROUBLE BELL AT FACP
5. TRANSMIT A TROUBLE POINT TO CENTRAL OFFICE

END OF SECTION 283111
SECTION 283111 – FIRE ALARM (WCMC)

PART 1 - GENERAL

1.1 DESCRIPTION

A. This specification describes an Individually Coded IFA with Voice. Provide coded alarm tone signaling using sounding devices to sound the alarm evacuation, and strobe lights, including firemen's HVAC override control panel. The system shall be analog addressable, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards.

B. Work described in this section shall be installed, wired, circuit tested, and calibrated by factory-certified technicians qualified for this work and in the regular employment of the company named on the UL listing card for the control equipment. The installing office shall have a minimum of ten years of installation experience with the manufacturer and shall provide documentation in the submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration, and checkout of the system shall be performed by the employees of the local factory-owned life safety system contracting field office. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

C. The fire alarm system shall comply with requirements of NFPA standard 72 for protected premises signaling systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

D. The system shall be an active/interrogative type system where each transponder and/or addressable device operates autonomously as a peer on the signaling line circuit. Devices shall process all conditions monitored and shall cause a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional and the specific condition being processed by the device. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.

E. The system shall have a fully digital emergency voice alarm communication system capable of supporting 8 channels of 1 way and 5 channels of two way communication. The digitized recorded voice message controller shall support a message library of over 1000 field programmed message phrases which can be arranged in any combination to create the necessary site specific message to notify occupants of any preprogrammed condition under both automatic and manual means.
F. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the fire command center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

G. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

H. The system and its components shall be underwriters laboratories, Inc. Listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

I. The installers shall be employees of the manufacturer or manufacturer’s parent company. The installers shall employ NICET (minimum level II fire alarm technology) technicians on site to guide the final check-out and to ensure the systems integrity.

J. All components of this fire alarm system must be provided from a single source manufacturer. These components include the fire alarm control panel, all associated system hardware, intelligent detection and control devices, audio/visual devices, manual pull stations, water flow switches, etc.

1.2 SCOPE

A. New intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance with the specifications and drawings.

B. The system shall be designed such that each signaling line circuit (SLC) is limited to only 80% of its total capacity at initial installation.

C. Basic performance:

1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 7 (Class A) signaling line circuits (SLC).

2. Initiation device circuits (IDC) shall be wired Class A (NFPA style D) as part of an addressable device connected by the SLC circuit.

3. Notification appliance circuits (NAC) shall be wired Class B.

4. On Style 7 (Class A) configurations a single ground fault or open circuit on the system. Signaling line circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

6. Speaker circuits shall be arranged such that there is a minimum of two speaker and strobe circuits per floor of the building or smoke zone which ever is greater.

7. Digital audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions. All off-normal conditions shall be annunciated in plain English on the system LCD display.

8. Digital audio amplifiers shall support multiple speaker circuits that are integral to and supervised directly by the amplifier. Speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

9. Two-way telephone communication circuits shall be supervised for open and short circuit conditions.

10. Speaker and strobe circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.

11. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Amplifiers shall be remotely located in transponder cabinets to simplify installation, provide distributed operation, and to reduce power losses in wiring.

12. Speaker circuits shall be 70 VRMS. Speaker circuits shall have 20% spare capacity for future expansion or increased circuit loading requirements.

13. Two-way telephone communication circuits shall be arranged so as to allow communication between the fire command center and up to twenty-eight (28) remote telephone locations simultaneously.

14. Means shall be provided to connect the telephone circuits to the speaker circuits to allow voice communication over the speaker circuit from a telephone handset.

15. Telephone communication shall be transmitted over the same digital communication bus used for audio evacuation messages.
16. Performance and capabilities are based on the Honeywell building solutions EBI life safety management system (LSMS).

17. The life safety management system (LSMS) system shall use a UL listed client server.

18. Architecture based around a modular pc network, utilizing industry standard operating systems, network devices, and protocols.

19. The system shall allow the distribution of system functions such as monitoring and control and graphical user interface across the network to allow maximum flexibility and performance. The architecture shall support various wide area networks (wan) using standard hardware and software to link nodes into a single integrated system. The network protocol shall be industry standard TCP/IP. The system shall support remote configuration and operation using standard dial-up modems.

20. Server computer and operator workstation hardware shall interface to an IEEE 802.3 standard local area network (LAN). The LAN shall use standard network cables. Acceptable cable types are thin Ethernet, thick Ethernet, fiber, and twisted pair.

21. LSMS management and control functions provided shall perform the following:

   1. Acknowledging, silencing, and resetting fire alarm and security event functions.

   2. Manually activating, deactivating, enabling, and disabling individual fire alarm and security points.

   3. Manually activating and restoring alternate sensitivity settings for smoke detectors.

   4. Manually activating and restoring alternate messaging on the life safety panel.

   5. Manually initiating and terminating fire drill.

   6. Manually initiating and terminating evacuation operation.

   7. Generating status, maintenance, and sensitivity reports for all fire alarm components.
8. Activating an audio wav file over the workstation speakers, alerting the operator to a fire alarm or security event.

9. Collecting and historizing data.

10. Managing alarms.

11. Trending.

12. Generating reports.


14. Managing data exchange and integration with a diverse range of other computing and facilities systems using industry-standard techniques.

15. Duplicate remote operator system display monitoring and control functionality.

22. At a minimum, the following data shall be accessible:

1. Panel alarms

2. Panel supervisory alarms

3. Panel troubles

4. Panel communications status

5. Device status

D. Basic system functional operation

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

1. The system alarm led shall flash.

2. A local piezo electric signal in the control panel shall sound.
3. The 640-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

4. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.

5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

6. The audio portion of the system shall sound the proper signal (tone or voice) to the appropriate zones.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.

B. Installer Qualifications: An experienced installer who is an authorized representative of the manufacturer for both installation and maintenance of units required for this Project.

C. Source Limitations: Obtain fire alarm system components through one source from a single manufacturer.


E. Comply with the New York City Electrical Code including New York City Amendments to the 2008 NEC, including Article 760, and in concert with the 2014 New York City Building Code.

F. Comply with the New York City Mechanical Code in concert with the 2014 New York City Building Code.

G. Comply with the rules, regulations, and requirements of the Fire Department of the City of New York being the Authorities Having Jurisdiction in concert with the New York City Department of Buildings.

H. Comply with all other applicable industry, national, and local codes, and authorities having jurisdiction as indicated on drawings and herein specified.
I. Fire alarm system shall be UL listed.

J. Submit three copies of all required Licenses and Bonds.

1.4 FACILITY OPERATIONS REQUIREMENTS

A. The system shall be installed and fully tested under the supervision of a trained manufacturer’s representative. The system shall be demonstrated to perform all of the function as specified.

B. The installing contractor or fire alarm equipment vendor shall have no less than two (2) NICET Level II fire alarm technicians dedicated to this project.

C. The Installing Contract and the Fire Alarm System Vendor shall, upon the request of the Consulting Engineer or End-User, attend any and all project meetings for the purpose of accurately determining progress.

D. It shall be the responsibility of the installing contractor to assure that construction debris does not adversely affect any sensing devices installed as part of this project. Should it be deemed necessary by the Consulting Engineer, End-User or AHJ, the installing contractor shall be responsible for the cleaning of all smoke detectors prior to final acceptance.

E. The fire alarm system vendor shall test the system in accordance with the manufacturer’s requirements and NFPA 72 as amended by the NYC Building Code. The vendor shall provide completed reports to the Consulting Engineer for review and approval prior to final acceptance.

F. Each individual system operation on a circuit by circuit basis shall be tested for its complete operation. The procedure for testing the entire fire alarm system shall be set forth with the consent of the code enforcement official, the Engineer and the manufacturer.

G. Submit the following Product Data:

1. Provide list of all types of equipment and components provided. This shall be incorporated as part of a Table of Contents, which will also indicate the manufacturer’s part number, the description of the part, and the part number of the manufacturer’s product datasheet on which the information can be found.

2. Provide description of operation of the system (Sequence of Operation), similar to that provided in Part 2 of this Section of the Specifications, to include any and all exceptions, variances or substitutions listed at the time of bid. Any such exceptions, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment. The sequence of operation shall be project specific, and shall provide individual sequences
for every type of alarm, supervisory, or trouble condition that may occur as part of normal or off-normal system use.

3. Provide manufacturer’s printed product data, catalog cuts and description of any special installation procedures. Poorly photocopied and/or illegible product data sheets shall not be acceptable and shall be rejected. All product datasheets shall be highlighted or stamped with arrows to indicate the specific components being submitted for approval.

4. Provide manufacturer’s installation instruction manual for specified system.

5. Provide shop drawings as follows:
   a. Coversheet with project name, address and drawing index.
   b. General notes drawing with peripheral device backbox size information, part numbers, device mounting height information, and the names, addresses, point of contact, and telephone numbers of all contract project team members.
   c. Device riser diagram that individually depicts all control panels, annunciators, addressable devices, and notification appliances. Shall include a specific, proposed point descriptor above each addressable device. Shall include a specific, discrete point address that shall correspond to addresses depicted on the device layout floor plans. Drawing shall provide wire specifications, and wire tags shown on all conductors depicted on the riser diagram. All circuits shall have designations that shall correspond with those require on the control panel and floor plan drawings. End-of-line resistors (and values) shall be depicted.
   d. Control panel termination drawing(s). Shall depict internal component placement and all internal and field termination points. Drawing shall provide a detail indicating where conduit penetrations shall be made, so as to avoid conflicts with internally mounted batteries. For each additional data gathering panel, a separate control panel drawing shall be provided, which clearly indicated the designation, service and location of the control enclosure. End-of-line resistors (and values) shall be depicted.
   e. Device typical wiring diagram drawing(s) shall be provided which depict all system components, and their respective field wiring termination points. Wire type, gauge, and jacket shall also be indicated. When an addressable module is used in multiple configurations for monitoring or controlling various types of equipment, different device typical diagrams shall be provided. End-of-line resistors (and values) shall be depicted.
   f. Device layout floor plans shall be created for every area served by the fire alarm system. CAD Files (AutoCAD – latest edition) shall be provided by the consulting engineer for the fire alarm system equipment vendor in the preparation of the floor plans. Floor plans shall indicate accurate locations for all control and peripheral devices. Drawings shall be NO LESS THAN 1/8 INCH SCALE. All addressable devices shall be depicted with a discrete address that corresponds with that indicated on the Riser Diagram. All notification appliances shall also
be provided with a circuit address that corresponds to that depicted on the Riser Diagram. If individual floors need to be segmented to accommodate the 1/8” scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner. End-of-line resistors (and values) shall be depicted.

g. Contained in the title block of each drawing shall be symbol legends with device counts, wire tag legends, circuit schedules for all addressable and notification appliance circuits, the project name/address, and a drawing description which corresponds to that indicated in the drawing index on the coversheet drawing. A section of each drawing title block shall be reserved for revision numbers and notes. The initial submission shall be Revision 0, with Revision A, B, or C as project modifications require.

6. Battery calculations shall be provided on a per power supply/charger basis based on 24 hours of supervision and 45 minutes of alarm. These calculations shall clearly indicate the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, totals for all categories, and the calculated battery requirements. Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws. Failure to provide these calculations shall be grounds for the complete rejection of the submittal package.

H. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance or approval by AHJ. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

I. Warranty
1. All material and equipment furnished under this contract shall be free from defects and shall remain so for the periods of time indicated by the schedule below.
   a. All fire alarm control panel, including communication interfaces, annunciators and LCD displays shall be warranted for a period of 2 years from date of installation.
   b. All fire alarm SLC devices, including input and output modules, sensors, manual pull stations and smoke detectors shall be warranted for a period of 2 years from date of installation.
   c. All remote power supplies, excluding those used as integral parts of fire alarm control panels, shall be warranted for 10 years from date of installation.

2. All installation work shall be warranted for period of one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid. Projects that
include a phased acceptance schedule shall commence the warranty on the date of acceptance of the phase.

J. Post contract maintenance
   1. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

   A. Basis-of-Design Product: Subject to compliance with requirements, provide product by the following:

      Honeywell International Inc. (Honeywell building solution factory branch) 353-A Vintage Park Dr., Foster City, CA 94404 (650) 918-3270 for design and quality.

      The manufacturing contractors shall use only products corresponding to the product line listed. Honeywell Enterprise Building Integrator (EBI) with Honeywell XLS3000.

2.2 CONDUIT AND WIRE

   A. CONDUIT

      1. Conduit shall be in accordance with the national electrical code (NEC), local and state requirements.

      2. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

      3. Cable must be separated from any open conductors of power, or class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC article 760.

      4. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices.
and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.

6. Conduit shall be 3/4 inch (19.1 mm) minimum.

B. WIRE

1. All fire alarm system wiring must be new.

2. Wiring shall be in accordance with local, state and national codes (e.g., NEC article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.

3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).

5. The system shall permit the use of IDC and NAC wiring in the same conduit with the multiplex communication loop.

6. All field wiring shall be completely supervised. In the event of power failure, removal of any internal modules, or any open circuits in the field wiring; a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

7. All voice speaker and telephone circuits shall use twisted/shielded pair to eliminate cross talk.

C. Terminal boxes, junction boxes and cabinets: all boxes and cabinets shall be UL listed for their intended purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as fire alarm. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or electrically bonded grounding rod.

2.3 COMMUNICATIONS

A. Server computer and operator workstation hardware shall interface to an IEEE 802.3 local area network (LAN). The LAN shall use standard network cables. Acceptable cable types are:
   1. Thin Ethernet
   2. Thick Ethernet
   3. Fiber
   4. Twisted pair
   5. NYC approved fire alarm cable

B. Contractor shall provide a dedicated Ethernet LAN communication media, connectors, repeaters, hubs, and routers necessary for the internetwork operation not specified elsewhere in section 13850, but required to provide the specified section 13850 functionality.

C. Contractor shall provide serial modem communication hardware, cabling, and RFI and EMI filters to allow for remote operator interface. Remote operator interface shall permit communication with all panels on this network as described in paragraph d below.

D. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
   1. Connection of an operator interface device to any one panel on the internetwork will allow the operator to interface with all other panels as if that interface were directly connected to the other panels. Data, status information, reports, system software, and custom programs for all panels shall be available for viewing and editing from any one panel on the internetwork.

   2. All database values (e.g., objects, software variables, custom program variables) of any one panel shall be readable by any other panel on the internetwork. A panel shall automatically perform this value passing when a reference to an object name not located in that panel is entered into the panel’s database. An operator or installer shall not be required to set up any communication services to perform internetwork value passing.
E. Time clocks in all panels shall be automatically synchronized daily via the internetwork. Operator changes to the time clock in any panel shall automatically broadcast to all panels on the internetwork.

F. The internetwork shall have the following minimum capacity for future expansion:
   1. Support greater than 90 separate communications links to networks of control devices.
   2. Support a minimum of 80 simultaneous operator workstation connections using TCP/IP local area network (LAN) subject to hardware capacity on the server.
   3. System size shall be expandable to at least two times the number of hardware and software input and output points required for this project, or 12,000 points, whichever is greater.

2.4 OPERATOR STATION INTERFACE

A. The fire alarm control panel(s) shall be connected to a supervising station provided in accordance with NFPA 72, chapter 8. The supervising station shall be UL 864 UOJZz listed for the primary operation, including acknowledge, reset, command, and control of the fire alarm system.
   1. Fire network adapters shall be provided to interface the xls-140 fire alarm system to operator workstations on the Honeywell Enterprise Buildings Integrator (EBI) building management system via a local area network (LAN).
   2. The FNA interfaces an XLS-NCS network control annunciator, XLS-NCM network control module, or XLS-NCS network control station to the UL 864 listed supervising station Ethernet LAN via 10baset or AUI ports on the FNA.
   3. The FNA shall be powered from an auxiliary 24 VDC output of a fire alarm control panel, or from a UL 864 listed fire alarm power supply.
   4. The FNA shall be FCC class a compliant, and UL 864 listed.

2.5 OPERATOR STATION

A. Operator interface: furnish dedicated pc-based workstations as shown on the system drawings. Each of these workstations shall be able to access all information in the system. The system shall support up to 80 simultaneous operator workstation connections using a TCP/IP local area network (LAN) subject to hardware capacity on the server computer. The network connection shall allow a limitless number of casual users access to the 80 connections on a first-come, first-served basis. Casual user shall only be used in an ancillary capacity for life safety applications. This project shall be licensed for 1 casual users.

B. Hardware: each operator workstation shall comprise the following minimum hardware:
Intel core 2 duo 2.66GHZ  
2GB of RAM  
Graphics card capable of 1280x1024 pixel resolution and 65k colors  
A 40 GB hard disk drive  
A 12 function-key keyboard  
A mouse pointing device  
TCP/IP adaptor  

Printers available for printing either reports or online alarms; report printers shall be any windows-compatible printer such as a laser printer, and alarm printers shall be 132-column printers to allow alarms to be printed as they occur.  

Ups (uninterruptable power supply) for each lsm's pc operator workstation; size for 50 percent spare capacity with sufficient capacity to allow emergency power for a minimum of 10 minutes backup  

Ul listed computer platform to be used when system is primary reporting system.

C. System software  
1. Operating system. Furnish a concurrent multitasking operating system. Operating system shall also support common software applications, such as Microsoft Excel, Microsoft Word, and Access. The networking software shall use industry standard TCP/IP LAN protocol. System peripherals shall be capable of being connected to the server computer via the LAN. The operator interface shall also be compatible with windows terminal services, allowing remote PDA devices to be used as mobile operator interfaces.  

2. System graphics: operator interface shall be graphically oriented and allow for efficient communication of operational data and abnormal conditions. Graphics shall support at least 65,000 colors at a minimum 1024 x 768 pixel resolution. It shall provide a consistent framework for viewing of information. Critical areas (such as alarm icons) shall be visible at all times. A predefined area on the screen shall provide operator messaging, and this area shall be visible at all times. A set of standard displays for configuration and navigation around the FMS system shall be provided with every system and not require any engineering. FMS shall also have an unlimited number of custom (facility-specific) displays created to meet the needs of the specific facility.  

3. Operator interface shall employ standard windowing conventions to reduce required operator training. Standard tool bar icons and drop-down menus shall be available on standard and custom displays to allow access to common functions. The tool bar and pull-down menus shall be fully configurable. Similarly, such functions shall also be available via a standard set of function-key-based pushbuttons without requiring configuration. The interface shall support a mouse and touch screen for pointing and command input.  

4. The operator interface shall support the ability to “full screen lock” the window so users cannot access other applications. If “full screen lock” is not enabled, support for copy-and-paste facilities shall be provided between the operator window and other Microsoft applications.
D. Operator interface characteristics: the system shall provide a Windows operator interface using dedicated icons and pull-down menus with the minimum capabilities listed below. No custom programming or scripting shall be necessary to produce the following:

1. Window re-size, zoom in, zoom out
2. Associated alarm display
3. Alarm summary
4. Alarm acknowledgment
5. Display sequence forward and backward
6. Previous display recall (minimum of eight displays)
7. Graphic call-up
8. Trend call-up
9. Point detail call-up
10. Card holder detail
11. Pop-up face plates
12. Alarm banner showing highest priority and most recent (or oldest) unacknowledged alarm
13. System date and time zone
14. Current security level
15. Workstation connection number
16. Alarm annunciation
17. Communications fail annunciation
18. Operator message zone

E. Operator functions: the following functions shall be performed through the operator interface:

1. Display and control field equipment.
2. Acknowledge alarms on a priority basis.
3. Initiate report printing.
4. Archive and retrieve event logs.
5. View intranet or information from the internet in a secure environment.
6. View ActiveX documents.
7. Use ActiveX controls.
8. Change own password.
9. Monitor data communications channels.
10. Configure system parameters.
11. Assign control confirmation messages to individual points.

F. The following standard system displays shall be included as part of the system. In the case of the trend and group displays, configuration of these displays shall only require entry of a point name to completely configure the display. The alarm summary, event summary, point detail, communications status, and system status shall not require any configuration. Systems
where standard graphical displays, showing all parameters for each system point, do not exist shall not be acceptable.

1. Alarm summary display
2. Event summary display
3. Point detail template displays (for each point in the database)
4. Trend set template displays
5. Group control and group trend template displays
6. Communications status displays
7. System status displays
8. Operator scratch-pad display
9. Face plates for all common point types
10. Configuration displays

G. Provide system status displays on the main operator workstation that display the following information:
1. Points in alarm condition pending acknowledge command
2. Points that remain in an alarm state, but which have been acknowledged
3. Communication failures
4. Printer status
5. Operator workstations status
6. Communication links status
7. Controller status

H. Provide system with the following full screen administrative displays:
1. Master system menu
2. Report summary
3. Alarm summary
4. Event summary
5. Display summary
6. System parameters configuration
7. Operator workstation configuration
8. Area assignment
9. Time schedule assignment
10. Holiday assignment
11. History assignment
12. Push-button assignment
13. Operator definition
14. Operator message board
15. Events archive and retrieval
16. Time period summary and configuration
17. Point detail for every configured point
I. The LSMS system shall provide a means by which a number of alarm inputs, outputs, and other related points can be grouped together for more convenient monitoring and control without the need for custom graphics.

J. Configuring time schedules shall be done through a graphical user interface where the operator selects the appropriate time span from a calendar. It shall be possible to specify time schedules for the control of all smoke and heat detector sensitivity settings. A large number of individual detectors shall be controlled by a single time schedule. A single time schedule shall define the control to any combination of day and time, e.g., Monday-Friday 7:00 to 18:00, Thursday 7:00 to 22:00, and Saturday-Sunday 9:00 to 14:00. The LSMS time schedule shall provide the ability to override the normal schedule for holidays or special occasions. Where the control device supports an internal time schedule program, the LSMS shall upload, display, modify, and download the control device time schedules. Support for the control device time schedules shall be in addition to the LSMS time schedules. Systems where times and days are manually entered are not acceptable.

K. The LSMS operator interface shall have access to online help and full system documentation. Online help shall be fully searchable and cross-referenced to all relevant sections of the documentation. It shall be possible to browse the online help and set “Favorites” that link to commonly used sections of the help information. Provide manuals online.

L. Provide LSMS system shall with a system diagnostics utility. Diagnostic information shall be viewable through an intuitive user interface exported as a standalone collection of material for later analysis. This information shall include communications traces to selected panels, system log files, details on system software installation, and application status information.

2.6 Operator station communication

A. The system shall support acquisition of data by using periodic scanning, report by exception (RBE), and data on demand. To minimize communications traffic, the system shall automatically block data requests using contiguous addresses and scan intervals to generate scan packets, optimizing throughput for a given scanning load. Provide utilities to examine scan packet allocation for each scan interval, and compile aggregate statistics on communication link usage. Where supported by the controlling device, RBE protocols shall be used to reduce the scanning load of the system while improving system response. If necessary, periodic scanning may be used in conjunction with RBE to ensure data integrity.

2.7 Operator security and sign-on

A. Operator shall be assigned a user profile that defines the following:
1. Security and control level
2. Operator identifier
3. Unique password
4. Area assignment and area profile
5. Start graphic for that operator
6. Timeout value for that operator

B. Any actions initiated by the operator shall be logged in the event database by operator identifier. In addition, any control actions to a given point shall only be allowed if the control level configured in the operator’s profile exceeds the level assigned to the controlled point.

C. Utilities shall be provided to allow administration of the operator passwords.

D. The system shall support at least six levels of operator security. The functions allowed from each security level shall be as follows:
   1. Level 1: signed off mode—view start-up display only.
   2. Level 2: view only—view displays; typically used for an inexperienced operator.
   3. Level 3: permit all level 1 and 2 functions and, in addition, permit the operator to control points such as start and stop, disable and enable, and to acknowledge alarms as they occur.
   4. Level 4: permit all level 1 through level 3 functions, in addition to accessing master time schedules, system peripherals allocation, change point engineering parameters, build reports, and most standard system configuration displays. Typically reserved for the building supervisor.
   5. Level 5: permit all level 1 through level 4 functions, in addition to accessing engineering functions, such as building and linking displays, and allocating keyboard push button assignments. Reserved for the building engineer.
   6. Level 6: this is the highest level of station security, typically allowing the user unlimited access to all station functions. Reserved for the building manager.

E. The operator shall be permitted to sign on to the system if the correct operator identity and password have been entered. This password shall be encrypted. It shall be possible to have the system linked to windows so that the operator uses their windows account name and password to sign on to the LSMS system. This ensures that operators only need to remember one set of credentials.

F. After a series of three unsuccessful attempts to sign on, the operator workstation interface shall be locked for a configurable period of time. The lockout period shall be set via system configuration displays. During operator workstation lockout, the other windows functions of the computer running the operator workstation software shall not be affected.

G. It shall be possible to assign operators either single or multi-user passwords. Single user passwords enable the operator to sign on to only a single operator workstation, thus
preventing simultaneous sign-on for the same operator. Operators with the highest sign-on security level may require simultaneous access to more than one operator workstation and would typically use the multi-user password.

H. The operator may sign off at any time by issuing a sign-off command. A keyboard time-out feature shall be provided so that the operator shall be automatically signed off after an adjustable time period of keyboard inactivity. It shall be possible to configure automatic sign-off to call up a predetermined "logged-out" graphic display to hide potentially restricted information embedded in the last display viewed prior to automatic time-out.

I. Each operator shall be assigned one or more specific areas of the building with the appropriate monitoring and control responsibility (no view, view only, alarm acknowledge only, or full control). An area shall be defined in this context as a logical entity comprised of a set of points in the system. This represents a physical space in the building. Areas shall be used to partition the database so as to assign operators control over certain areas and prevent unauthorized access to other areas.

J. Operators shall create area profiles, which combine areas and time periods, and which can be assigned to operators with the same area access requirements. By using area profiles in this way, area access can be specified to apply during certain time periods, allowing different areas of access at different times of the day or week.
   1. It shall be possible for an operator to indicate signing on under duress. The system shall recognize this and issue a command to alert appropriate personnel for assistance.

K. It shall be possible to assign to each operator a set of allowed commands for each assigned area, where an area is a group of points. These commands shall be mapped against the output state of any given digital point in the respective area to determine whether a control command is allowed for the particular operator. With this feature, for example, it shall be possible to configure an operator to set a digital point to on, but to disallow the same operator from setting the same digital point to off.

2.8 CUSTOM DISPLAY CREATION

A. Provide a graphic display-building editor for the creation of site-specific graphic displays. It shall allow one-step online building of display static and dynamic objects. It shall be a WYSIWYG editor (what you see is what you get), allowing displays drawn using the editor to appear exactly the same when viewed from an operator workstation.

B. Create displays in the html (hypertext markup language) format. This is essential so that the displays can be viewed through a web browser as well as the normal LSMS operator
interface. Save displays in the standard html format. Graphic elements shall be html elements. It is not acceptable to have an html format which merely links to a proprietary object or bit map of the entire display. View and edit the resulting html file using a text editor. Systems that do not support html displays shall not be acceptable.

C. Use the graphic display-building editor to create static objects, including static text, rectangles, arcs, and circles. Animate static objects to provide the dynamic characteristics of the real-world object the point represents.

D. Link dynamic objects to the LSMS database. This shall permit information to be displayed from the database or allow an operator to interact with the objects in order to make changes in the database and perform control actions. Dynamic objects shall include dynamic text, push buttons, indicators, charts, check boxes, combo boxes, pop-up boxes, ActiveX controls, and scroll bars.

E. Include static and dynamic display objects on one display. The editor shall allow display objects to be manipulated by pointing, clicking, and dragging. The editor shall allow display objects to be drawn, re-sized, copied, grouped, rotated, aligned, and layered over each other. It shall be possible to copy and paste objects within and between displays.

F. The graphic display-building editor shall support the following features:
   1. One-step display building (both background and dynamic information)
   2. Point and click operation
   3. Paste to and from the clipboard
   4. Absolute positioning object placement
   5. Ruler and grid
   6. Configurable tool, color, and line palettes
   7. Dialog boxes for definition of object properties
   8. Shape and page building
   9. On-line help
   10. Importable graphics from third-party packages, including WMF, BMP, TGA, GIF, and JPEG formats
   11. Standard library of LSMS industry objects
   12. Live video element
   13. Building of face plates
   14. ActiveX control
   15. ActiveX documents
   16. Display scripts written in either JavaScript or VBScript
   17. Multilevel undo and redo
   18. Object manipulation, including combine, union, and intersection
   19. Polyline node editing
   20. Transparent images
G. Animate display elements using standard html scripts such as JavaScript or VBScript. A script editor supporting one of the standard script languages shall be provided. By using script programs, individual elements on the display may be manipulated. A proprietary scripting language or additional scripting and drawing package shall not be acceptable. It shall be possible to perform a variety of animations, which include but are not limited to moving, resizing, and re-coloring objects, and providing pop-up messages and dialog boxes.

H. Scripts may be activated on displays using the following events:
   1. On mouse click
   2. On mouse enter
   3. On mouse move
   4. On page call-up
   5. On a timer
   6. On value or state change of a point on the display

I. Both the graphic display-building editor and the operator interface shall have built-in support for the creation and display of live video objects without the need for programming. The size and position of the video object shall be configured on a per-display basis. Systems that show the live video object in a separate window from the operator interface or on a separate monitor screen shall not be acceptable.

J. Create displays in the graphic display-building editor using a web browser such as Microsoft’s internet explorer without modification. All displays shall be usable in this manner, enabling operators to completely operate the system through a web browser if required. Displays shall incorporate data from an intranet, the internet, or ActiveX documents, along with other building data.

K. Launch applications (such as Microsoft Word, Excel, custom help files, or any third-party applications) from a custom display. If supported by the application, it shall be possible to launch the application with a specified file opened within the launched application. Launching of such applications shall be possible from the operator workstation pull-down menus or from a push button on a custom display.

2.9 SYSTEM DATABASE

A. Provide a real-time database incorporating data from analog, digital, or pulse inputs. The database shall be configurable by the end user without the need for any programming and shall be modified on-line without interrupting operation of the system. In addition to point-based information, the database shall provide historization capabilities for analog, digital, pulse, and event-based information. This information shall be accessible by all facilities of
the system, such as custom displays, reports, trends, and user-written applications. The real-time database shall support collection of data and storage using the following structures:

1. Access point structures
2. Analog point structures
3. Status point structures
4. Accumulator point structures
5. Virtual point structures
6. Historical data structures
7. Event data structures
8. User defined structures

B. Each of the point database structures shall be comprised as a composite point with a number of associated parameters, which shall be referenced relative to a single point id name. Specifically, each of these parameters shall be accessible by various subsystems, such as the graphical operator interface, report generation system, and application program interface, in a simple point parameter format without needing to know any internal storage mechanism.

C. Database backup shall be possible with the system on-line including backup of historical-based data. The backup shall use standard Microsoft windows 2000 operating system utilities.

D. Store point data in a composite point database structure that provides a wide range of configurable information, including but not limited to:

1. Point id name and description
2. Multiple locations for data storage and device scanning addresses
3. Scan period
4. Multiple types and instances of alarms
5. Multiple deadband or hysteresis settings (analog points)
6. Monitoring and control access restriction information
7. Location of operator alarm-handling instructions
8. Location of ancillary information associated with the point
9. A list of all recent events, a minimum of 10, pertaining to that point

E. The LSMS system shall provide a means by which a number of alarm inputs, outputs, and other related points can be grouped together for more convenient monitoring and control without the need for custom graphics.
F. In order to support other types of data, such as user-entered or calculated data from application programs, the system shall provide a user definable database area that can be fully integrated into the system. Data contained in this database shall be accessible by custom graphics, custom reports, application programs, and network applications using a network API.

2.10 SYSTEM DATABASE CONFIGURATION

A. Provide a database configuration tool that allows configuration of all point records, printers, panels, and operator workstation connections. This utility shall be in the form of a relational database and operate in a true 32-bit graphical environment such as Windows 2000. The utility shall export information to and import information from Microsoft applications such as Microsoft Excel. Systems that do not provide support for Microsoft Excel 2000 in this respect shall not be acceptable.

B. Users with sufficient security access shall configure the database while the system is on-line. Configuration shall not require any programming, compiling, or linking, and shall not require shutting down or restarting of the system. In addition, historical data collection shall not be interrupted for points not affected by configuration changes.

C. Database configuration tool shall launch from the operator workstation interface. Utility shall configure database changes and download them either from the LSMS server directly or remotely via the network. Remote download applications shall be password protected.

D. It shall be possible to modify a range of communications and other parameters for each device. The parameters of a particular device made available for modification shall be specific to the device or hardware item being configured—for example, baud rate, parity, data, and stop bit information in the case of serial devices. Hardware configuration utilities that rely solely on text-based configuration files shall not be acceptable.

E. Provide documentation for the configuration utility on-line. Help facility shall operate using standard Microsoft features, such as context-sensitive help using the f1 function key.

F. Utility shall reduce configuration time of the LSMS system. These features shall include adding multiple points and panels at once. Utility shall automatically increment names or numbers of any information that is required to be unique by the LSMS system (such as point names). User shall select multiple items (such as points) and then edit fields that are common to all selected items to assist in global changes. Standard copy and paste facilities shall be provided by the utility.

G. Utility shall support free format text fields, which the user can use for additional information such as cabinet or wire numbers. These additional fields shall be simple extensions to existing items in the database such as LSMS points.
H. Provide a filtering mechanism to enable the user to view only relevant information. The filter shall provide standard choices for the user to select, and provide user-defined filtering.

I. Provide database management reports as standard. Utility shall provide support for ad-hoc reporting facilities for engineering use.

2.11 APPLICATION PROGRAMMING INTERFACE

A. Two types of application programming interface (API) are required. The first is for applications written on the LSMS server, and the second is for applications required to run on network-based clients (that are not necessarily operator workstations). The LSMS system APIS shall have support for either visual basic or C++, or both. Proprietary programming languages are not acceptable.

B. The API on the LSMS server requires the following functions as a minimum:
   1. Read and write to points in the database
   2. Access to historical data
   3. Initiate supervisory control actions
   4. Access to the alarm and event subsystem
   5. Access to user-defined database
   6. Provide a prompt for operator input

C. The API on the network-based clients requires the following functions as a minimum:
   1. Read and write to points in the database
   2. Access to historical data
   3. Initiate supervisory control actions
   4. Access to user-defined database

2.12 SERVER SCRIPTING ENGINE

A. The LSMS system shall extend its functionality by the addition of small script code to certain server functions. This will enable additional customer-specific functionality to be easily added to point, report, and server processing. For example, a script shall enable a calculation to be performed and a number of points to be controlled based on another point going into alarm state. Scripts shall be able to be attached to point processing, report generation, server startup and shutdown, or executed on a periodic basis.

B. Provide a scripting engine that supports a standard scripting language such as Microsoft’s VBScript. Access to the scripts shall be through an inbuilt scripting editor that provides key
work support and syntax checking as well as an extensive range of online help, including a large number of worked examples. Proprietary scripting languages shall not be acceptable.

C. Scripting functionality shall be in addition to a full application programming interface as described in the article above.

2.13 DIAGNOSTIC CAPTURE TOOL
A. Diagnostic information indicating the health of the system shall be viewable through a user interface and shall be exported as a standalone collection of material for later analysis. This information shall include:

1. Communications traces to selected panels
2. All system log files
3. Details on system software installation
4. Application status information

2.14 HISTORY MANAGEMENT

A. Collection of historical point data shall be configurable as part of the point definition. Once configured, this data shall be collected automatically. Historical data collection shall be provided for both snapshots and averages with intervals ranging from 1 second to 2424 hours.

B. Once assigned to history, point data shall be available by POINT.PARAMETER access used in conjunction with a history offset to locate the particular value of interest. The graphical operator interface, trend, report generation, and application interfaces shall access historical data.

C. Modifications to the history collection of a point shall be possible on-line without the loss of previously collected data for the point being changed or any other points in the system currently being historized.

D. History shall be archived to an alternative file system or offline media. Different archive settings shall be available for different history types

2.15 TRENDING

A. Provide flexible trending allowing real-time, historical, or archived data to be trended in a variety of formats. In addition, trend data types shall be combined to allow for comparisons
between data, e.g., current real-time data versus archived data. The system shall provide

trending capability with the following functions:

1. Real-time trending
2. Historical trending
3. Archived history trending
4. Trend scrolling
5. Trend zoom
6. Engineering unit or percent
7. Cursor readout of trend data
8. Trend comparisons between archived, real-time, and historical data (for example, this
   year vs. Last year). Comparisons between the same point offset in time, or different
   points shall be possible.
9. Trend de-cluttering via per-pen enable and disable on multi-plot style trends
10. Independent y-axis per point on multi-plot style trends. It shall be possible to display
    the y-axis for any point on the trend by simply selecting the point using the mouse or
    keyboard.
11. Copying the currently displayed trend data to the clipboard for pasting into a
    spreadsheet or document.

B. Configuration of trends shall only require the entry of the point name into the desired trend
    template to produce the trend. All trend configuration shall be possible on-line without
    interruption to the system. Historization of data shall not be affected by changes to trend
    configuration. Systems that only provide trending via a third-party package will not be
    acceptable.

C. The system shall be able to present real-time, historical, or archived data in a variety of
    formats, including single, dual, and multiple value trends of up to eight points. For each
    trend set display, it shall be possible for operators to configure the number of historical
    samples and ranges displayed. Points configured in trend sets shall be changeable on-line.

D. Operators shall be able to zoom in on information displayed on trend sets for closer
    inspection by dragging out an area of interest with the mouse or other pointing device. From
    such a selection, it shall be possible to copy the underlying data to the windows clipboard
    for subsequent pasting into a spreadsheet application such as Microsoft Excel 2000. Systems
    that do not provide support for Microsoft Excel 2000 in this respect shall not be acceptable.

E. Scroll bars shall be available to move the trend set backwards and forwards across the
    historical records. The trend sets shall automatically access archived history files without
    operator configuration.

F. Embed trend objects as part of custom displays. The following formats shall be available:
   1. Bar trend
2. Line trend
3. Numeric trend
4. Tuning trend
5. Pie trend
6. X-y plot

2.16 EVENT MANAGEMENT

A. Log an event so that it is journalized in the event file and optionally printed on the event printer. The journal shall contain the following event information:

1. Alarms
2. Alarm acknowledgements
3. Return to normal
4. Operator control actions
5. Operator login and security level changes
6. On-line database modifications
7. Communications alarms
8. System restart messages
9. Database changes

B. Provide standard displays to show the current journal file with the most recent event at the top of the display. Page forward to display progressively older events. Sort and filter the journal directly on screen. Save filters for future use. Print filtered events as an event report directly from the event display. The event database entries shall contain the following information as a minimum:

1. Time and date stamp
2. Database partition code
3. Source
4. Operator
5. Event type
6. Condition
7. Action
8. Alarm priority
9. Description
10. Value
11. Engineering units
12. Comments

C. Sort events by time and date, database partition, or source of the event. Apply filters to the list of events to limit the view of events to those that match the filter. Filters may include multiple dimensions and wildcards and shall be saved and restored for reuse.
D. Provide additional fields that are relevant for different types of events. It shall be possible to enter comments on all events so those operators can annotate an event with relevant information.

E. Manually create an event if the operator wishes to record an incident on the site that is unrelated to system equipment.

F. Event database shall be accessible from other subsystems, such as the operator interface, report generation, and application programmers’ interface. It shall be possible to have an on-line event file as large as the disk capacity can accommodate. For example, given the appropriate disk space, it shall be capable of storing more than 1,000,000 events on-line.

G. Event file shall store events online. The system shall automatically and manually archive these online events periodically, at a time period specified by the user. Operators shall be notified by an alarm that event archiving is required if manual operation is chosen. Events may be archived to tape or to other media such as cd, zip drive, or another file system. If archiving does not take place, the event system shall continue to collect events until it reaches a nominated disk space limit. It shall then overwrite the oldest events until archiving takes place or more disk space is made available.

H. Archived events may be restored to the LSMS at a later time if required for reporting purposes. Multiple archives shall be restored at any one time. LSMS shall indicate to the operator the range of events in a particular archive file.

I. Event management system shall be fully integrated with the standard reporting system. The system shall automatically reference the restored archive file if a report is requested containing a time search window covered by the current archive file. Operator shall be able to restore previously archived files and review or print them from the operator workstations. It shall also be possible to directly generate a report from the event database filtered online without necessarily using the reporting system.

2.17 ALARM MANAGEMENT

A. LSMS shall support the following different types of alarms for analog sensitivity values associated with smoke and heat detector points or any other analog point type. Any four of these alarms shall be assignable to each analog or accumulator point on an individual point basis as part of the point configuration process. Status points shall allow each individual state to be alarmed.
1. Two high-value alarms
2. Two low-value alarms
3. Two deviation alarms
4. Rate of change alarm
5. Unreasonable value alarm

B. Each monitored point in the system shall be assigned one of four alarm priorities to individual states. Within each of the four alarm types there shall be 15 sub-priorities available. Each alarm priority shall have a configurable color. The meaning of the priorities shall be as follows:

1. Journal: changes of state shall be journalized to the alarm and event log and optionally printed on the alarm and event printer.

2. Low: change of state will generate a low priority alarm, which will appear on the alarm summary. Optionally, the alarm may be printed on the alarm and event printer or generate an audible tone.

3. High: change of state will generate a high priority alarm, which will appear on the alarm summary. Optionally, the alarm may be printed on the alarm and event printer or generate an audible tone.

4. Urgent: this is the highest priority. Change of state will generate an urgent priority alarm, which will appear on the alarm summary. Optionally, the alarm may be printed on the alarm and event printer or generate an audible tone.

C. It shall be possible to configure a time so that if a low priority alarm is not acknowledged within this time the alarm’s priority is elevated to high priority. If a high priority alarm is not acknowledged within a configured time, its priority is elevated to urgent priority.

D. For each alarm priority, it shall be possible to configure a point so that if any alarms of this priority occur, the point is controlled to the configured state. This could be used to drive external annunciators such as sirens or lights.

E. When an alarm is acknowledged, it shall be possible to automatically issue a reset to a panel to indicate the alarm is acknowledged and to attempt to reset the alarm point.

F. Alarms shall be annunciated at the operator workstation even if there is no operator currently signed on. This feature shall be available on network-connected operator workstations as long as the computer running the operator workstation software remains logically connected to the network. If the operator workstation is minimized in the windows environment, then the operator workstation icon will indicate an alarm. An audible tone
shall be able to be generated and this tone shall be specified by a "*.wav" or other sound file for each alarm priority.

G. Points shall be annunciated while in alarm. If a point is set to alarm-inhibited, the point shall no longer cause annunciation. If a point goes into an alarm state while inhibited and then is still in the alarm state when the point is set to alarm enabled, the point shall immediately cause annunciation. Alarms shall be annunciated by:
   1. most recent, highest priority alarm message appearing on dedicated alarm
   2. Banner on the operator interface.
   3. Available tone—based on a "*.wav" or other sound file for each alarm priority.
   4. Alarm message printed on the alarm printer.
   5. Alarm indicator flashing on the operator interface

H. Assigning an alarm to the point shall automatically cause the system to perform the following actions when an alarm occurs:
   1. The alarm shall be time-stamped to the nearest second and logged in the event database with the point name (source), alarm type, alarm priority, point description, new value, and engineering units.
   2. The point value that is in alarm shall turn red (or other configurable color) and flash on any standard or custom display using that point.
   3. An unacknowledged alarm entry shall be made in the system alarm summary for low, high, and urgent alarms.
   4. The audible alarm shall sound (if configured).
   5. The alarm annunciation indicator shall flash.

I. Alarms shall be viewed in a consolidated alarm summary that shows all current or pending alarms on the system. This summary shall be sorted by time and date, database partition, or source of the alarm. The fields shown on the alarm summary shall be configurable and it shall be easy to move or change the alarms fields displayed. It shall be possible to apply filters to the list of alarms to limit the view of alarms to those that match the filter. Filters may include multiple dimensions and wildcards and shall be saved and restored for reuse. More detail about an alarm shall be obtained from a configurable detail screen that shows all fields associated with that alarm. Operators shall have the flexibility to add comments to the alarm, and these comments shall be stored with the alarm.

J. A dedicated alarm banner shall appear on all displays showing either the most recent or oldest (configurable), highest priority, unacknowledged alarm in the system. Banner shall be clear when there are no unacknowledged alarms for the operator to process. An alarm indicator shall appear on all displays. This indicator will flash red (or another configured color) when there are any unacknowledged alarms pending in the system. Indicator will
remain solid red if there are alarms that have not returned to normal but have been acknowledged. Indicator will be clear if there are no points in an alarm condition.

K. Alarms shall be logged on the printer and event file for future retrieval in alarm reports or archived to removable media.

L. By pressing a dedicated key at any time, the operator shall be able to view a display showing all currently active alarms. Alarm messages shall be color-coded showing priorities. Operator shall be able to view the alarms according to priority or sorted based on other fields. It shall be possible to acknowledge alarms from this display and go to the associated display defined for the point.

M. On acknowledgment by the operator, the flashing indicator shall turn steady, and the point value shall remain red on any system or custom graphic. The acknowledgment shall be logged in the event database identifying the operator or station that acknowledged the alarm. If the point goes out of alarm before being acknowledged by the operator, the alarm shall be shown by a different indication and remain in the list until specifically acknowledged by the operator. If a point is not acknowledged within a configurable period of time, then an additional area based alarm can be generated. Provide for efficient alarm acknowledgement in the following ways:

1. Selecting any point parameter from a custom graphic and pressing the dedicated acknowledge push-button
2. Selecting the alarm banner and pressing the dedicated acknowledge button
3. Selecting the alarm in the alarm summary display and pressing the dedicated acknowledge button
4. Performing a page acknowledge from the alarm summary display

N. The alarm summary shall filter the alarms displayed to the operator. Columns on the alarm summary shall be used as part of a filter, allowing sophisticated filters to be configured (e.g., all alarms from this particular point, with this value, during this period). Filters shall be saved and restored so that previously configured filters can be reused. It should be obvious to operators when a filter has been applied to the alarm summary.

O. System shall allow the linking and display of digital video recordings pertaining to alarms. If there is any video footage in digital format that is relevant to an alarm, then the alarm summary shall indicate this by the use of a special icon on the alarm. By selecting the icon, the operator can then replay the relevant digital video footage of the alarm incident.

P. The filtered alarm summary should be able to be printed directly as a report. From the alarm summary page, it shall be possible to view the current filtered list of alarms via a
print preview button. From the alarm summary, it shall be possible to print the alarms directly using the print button.

Q. The LSMS system shall provide for an additional message to be tagged to the alarm. This message shall provide the operator with additional information on the alarm, but shall not clutter the alarm summary. It shall appear in a separate message summary at the same time as the alarm appears in the alarm summary. Messages can be pre-configured and then simply attached to individual points by means of a message id.

R. LSMS shall provide advanced alarm management, which includes set stages of alarm handling. All actions shall be recorded in the event file for retrieval and auditing purposes. When an alarm is silenced, an instruction page for the alarm will be displayed. Alarm may then be acknowledged from this page and alarm handling action completed. Once the alarm is acknowledged and appropriate action taken, the operator may move to the response page to select from up to 100 user-defined responses to be logged in the event file. Alternatively, the operator shall enter his or her own response, which is logged in the event file. Simultaneously the alarm is removed from the alarm file or the point shall remain on the alarm summary until a manual reset operation is performed. It shall be possible to enable and disable this feature on a point-by-point basis, given the appropriate system privilege level. The stages are:

1. Silence alarm condition
2. Acknowledge and action alarm condition
3. Respond to alarm condition by using pre-defined responses
4. Optionally reset alarm

2.18 REPORTING

A. System shall support a flexible reporting package to allow easy generation of report data. Reports shall include pre-configured standard reports for common requirements, such as alarm event reports and user-configured custom reports. Configuration of these reports shall only require entry of the schedule information and other parameters—such as point name or wildcard, filter information, time interval for search, and destination printer—to fully configure the report. Specifically, no programming or scripting shall be required. The following pre-formatted reports shall be available on the system:

1. Alarm and event report
2. Operator trail report
3. Point trail report
4. Alarm duration report
5. All point report
6. After hours alarm report
7. Point attribute report
8. Generic or custom report

B. Alarm event report: produce a summary of all events of a specified type for nominated points occurring in a time period. Time period may be specified as an absolute start and end date and time, or as a period relative to the current time. Report shall be able to produce a summary of all changes made by a specific operator.

C. Operator trail report: produce a summary of all operator actions relating to a specific operator in a specified period.

D. Point trail report: produce a summary of all events of a specified type occurring in a period on nominated points.

E. Alarm duration report: calculate the total amount of time a nominated point or group of points has been in an alarm condition over a given time period. Time period may be specified as an absolute start and end date and time, or as a period relative to the current time.

F. All point report: produce a list of point information, including point name, description, point type, engineering units, and current values. Report configuration shall allow filtering based on a wide variety of criteria.

G. After hours alarms report: produce a summary of all alarms occurring during the period specified by the operator as “after hours.”

H. Point attribute report: produce a summary of points selected by one of the following attribute criteria
   1. Out-of-service
   2. Alarm suppressed
   3. Abnormal input levels
   4. In manual mode

I. Generic or custom reports: configure report-generation facilities to allow the production of custom reports. They may be configured at any time with the system on-line, and shall be capable of accessing any database values. At least two methods of custom report generation shall be available, including:
   1. LSMS shall provide the facility for the use of Microsoft Excel as a reporting tool, allowing calculations such as summations, maximal, minimal, and standard deviations, and the production of graphs, charts, and tables. Data accessible for excel reporting shall include alarms, events, and point parameter values. Systems that do not provide support for Microsoft Excel 2000 in this respect shall not be acceptable.
2. LSMS shall provide selected data in an ODBC format for the purpose of extracting data and creating custom reports. It shall be possible to access tables of data from the LSMS through an ODBC compliant tool such as crystal reports. It shall incorporate the activation of custom reports created through the ODBC compliant tool through the standard LSMS report subsystem. A report detail display shall allow naming of reports, scheduling information, and the destination of the report. The report destination shall be a printer, operator interface, or internal file. The report output format shall be html (hypertext mark-up language), Microsoft Word, or RTF format.

J. Reports shall be activated in one or more of the following ways:

1. Periodic activation at user-specified intervals
2. Operator demanded
3. Event initiated, e.g., change in point value
4. Application initiated
5. Printed directly from the alarm and event summary

2.19 POINT INITIATED PROGRAMS (PIPS)

A. In addition to standard point-processing functions, the system shall allow additional processing through the use of standard pips that may be attached to any points. Typical functions to be provided by these pips are listed below:

B.

1. Maximum and minimum value
2. Composite alarms
3. Group alarm inhibit
4. Report request by point change
5. Application program request (by point value change or cyclic period)
6. Alarm transportation
7. Value transportation
8. Door activity task request
9. Security area seal and unseal
10. Alarm or point value change graphic call-up
11. Value change group or area alarm inhibit

2.20 HISTORICAL DATA ARCHIVING
A. System shall support archiving of historical data to allow a continuous record of history to be built up over a period of time. Archived data may be stored on the hard disk of the system on a remote network drive, or it may be moved off-line to removable media such as floppy disk, cartridge tape, DAT tape, or optical disk. The number of archives maintained on the system before transferal to off-line media shall only be limited by the size of the hard disk or remote network drive. System shall permit the user to define the specific intervals of history to be archived to avoid archiving of unnecessary data.

B. Once archived, the data shall be available for re-trending through the system trend facilities in combination with the current on-line history or other archives. Providing the archived history is present on the LSMS server's hard disk or remote network drive, the trend facilities shall be able to access it transparently for display, when a user scrolls beyond current on-line history limits.

2.21 INTEGRATION PROTOCOLS

A. Existing fire system integration: provide an interface to the existing Honeywell fire and security bus for each node on the project site. The interface shall be UL 864 UOJZ listed for full command and control functionality and provide redundant communications channels. The unit shall be designed and listed to co-exist with existing Honeywell fs90 or fs90 plus panels on a common communications bus. A single bus may not contain more than 1500 alarm points. The interface shall be compatible with both the Honeywell gateway (bus interface) and MPCP board system architectures for future expansion and shall support the use of fiber optic driver cards. The interface shall mount within the node and be powered directly from it. Loss of, or fault in, communications shall cause a trouble indication at the operator workstation and on the life safety panel. The interface shall be supplied by the same manufacturer as the life safety panel and shown as a listed component on the ul listing cards for the product.

B. The system shall be capable of exporting bulk data to Microsoft excel. As a minimum, the following shall be supported:
1. Retrieval of data either periodically or snapshot
2. Retrieval of data via POINT.PARAMETER requests
3. Retrieval of tag names and descriptions
4. Retrieval of historical data
5. Write values from excel back to the supervisory system

C. LSMS shall provide for paging and external annunciation of configured points in alarm to alphanumeric pagers, digital mobile phones with text message (SMS) support, e-mail, and SNMP message. Each point’s paging priority threshold shall be individually configurable,
and individually enabled or disabled. Each external device configured in the system shall have individually selectable times and days of operation, an alarm priority threshold, and an alternative device for use in escalation of unacknowledged alarms.

2.22 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE

A. The main FACP central console shall be a Honeywell model XLS3000 and shall contain a microprocessor based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.

1. In conjunction with intelligent loop control modules and loop expander modules, the main FACP shall perform the following functions:
   a. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
   b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
   c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to a degraded mode. Such degraded mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated notification appliance circuits.
   d. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
   1) When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
      a) The system alarm led shall flash.
      b) A local piezo-electric audible device in the control panel shall sound a distinctive signal.
      c) The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
      d) Printing and history storage equipment shall log and print the event information along with a time and date stamp.
      e) E. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
2) When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
   a) The system trouble led shall flash.
   b) A local piezo-electric audible device in the control panel shall sound a distinctive signal.
   c) The 640-character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
   d) Printing and history storage equipment shall log and print the event information along with a time and date stamp.
   e) All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

3) When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
   a) The system trouble led shall flash.
   b) A local piezo-electric audible device in the control panel shall sound a distinctive signal.
   c) The 640-character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
   d) Printing and history storage equipment shall log and print the event information along with a time and date stamp.
   e) All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

4) When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
   a) The system security led shall flash.
   b) A local piezo-electric audible device in the control panel shall sound a distinctive signal.
   c) The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
   d) Printing and history storage equipment shall log and print the event information along with a time and date stamp.
   e) All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated
5) When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
   a) The system pre-alarm led shall flash.
   b) A local piezo-electric audible device in the control panel shall sound a distinctive signal.
   c) The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
   d) Printing and history storage equipment shall log and print the event information along with a time and date stamp.
   e) All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

B. Operator control
   1. Acknowledge switch:
      a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDS from flashing mode to steady-on mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support block acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
      b. Depression of the acknowledge switch shall also silence all remote annunciator piezo sounders.

C. Signal silence switch
   Depression of the signal silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers

   1. Drill switch: depression of the drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
   2. System reset switch: depression of the system reset switch shall cause all electronically latched initiating and indicating devices to return to their normal condition.
3. Lamp test: the lamp test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

4. Scroll display keys: there shall be scroll display keys for fire alarm, security, supervisory, trouble, and other events. Depression of the scroll display key shall display the next event in the selected queue allowing the operator to view events by type.

5. Print screen: depression of the print screen switch shall send the information currently displayed on the 640-character display to the printer.

D. System capacity and general operation

1. The control panel shall be capable of expansion via up to 10 SLC interface modules. Each module shall support a maximum of 254 analog/addressable devices for a maximum system capacity of 2540 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices.

2. The fire alarm control panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a keypad for the control of the fire alarm system. Said LCD shall also support custom graphic bit maps.

3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel. Laptops are not considered special equipment.

4. The FACP shall be able to provide the following software and hardware features:

   a. Pre-signal and positive alarm sequence: the system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a positive alarm sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

   b. Smoke detector pre-alarm indication at control panel: to obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of pre-alarm indication shall be available at the control panel: alert and action.

   c. Alert: it shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

   d. Action: if programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action pre-alarm level, with general evacuation on alarm level.
e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

f. Device blink control: means shall be provided to turn off detector/module LEDs for desired areas.

g. NFPA 72 smoke detector sensitivity test: the system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72.

h. Programmable trouble reminder: the system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

i. On-line or off-line programming: the system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a personal computer/laptop. A single change to one CPU database shall not require a database download to other CPUS.

j. History events: the panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event alarm history buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.

k. Smoke control modes: the system shall provide means to perform FSCS mode smoke control to meet NFPA-92a and 90b and HVAC mode to meet NFPA 90a.

l. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that id with the corresponding address of the device.

m. Drill: the system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.

n. Passwords and users: the system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

o. Two wire detection: the system shall support standard two wire smoke detection devices. Specifically, all models of system sensor devices, FENWAL PDS-7125/7126 and CPD-7021, HOCHIKI model SLK-24F/24FH, EDWARDS 6250B/6270B and 6264B and SIMPLEX models 2098-9201/9202 and 9576 shall be supported. System shall be capable of supporting intelligent 2 wire detection modules. These modules shall support a single 2 wire IDC or up to six (6) IDCS on the same module.
p. Block acknowledge: the system shall support a block acknowledge for trouble conditions
q. Sensitivity adjust: the system shall provide automatic detector sensitivity adjust based on occupancy schedules including a holiday list of up to 15 days.
r. Environmental drift control: the system shall provide means for setting environmental drift compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
s. Custom action messages: the system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
t. Print functions: the system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last walk test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broadcast time, event ordering, and block acknowledge, panel timer values for auto silence, silence inhibit, ac fail delay time and if enabled, proprietary reminder, and remote reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, prealarms, disabled points and activated points, all installed points filtered by SLC points, logic zones, annunciators, releasing zones, special zones, and trouble zones.

u. Local mode: if communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

v. Resound based on type for security or supervisory: the system shall indicate a security alarm when a monitor module point programmed with a security type code activates. If silenced alarms exist, a security alarm will resound the panel sounder. The system shall indicate a supervisory alarm when a monitor module point programmed with a supervisory type code activates. If there are silenced alarms, a supervisory alarm will resound the panel sounder.
w. Read status preview - enabled and disabled points: prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This
shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

x. Custom graphics: when fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.

y. Multi-detector and cooperating detectors: the system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.

z. Tracking/latching duct (ion and photo): the system shall support both tracking and latching duct detectors either ion or photo types.

aa. Active event: the system shall provide a type id called fire control for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a fire control point shall cause the control panel to (1) initiate the monitor module control-by-event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) shall display active on the LCD as well a display a fire control type code and other information specific to the device.

bb. Non-fire alarm module reporting: a point with a type id of non-fire shall be available for use for energy management or other non-fire situations. Non-fire point operation shall not affect control panel operation nor shall it display a message at the panel LCD. Activation of a non-fire point shall activate control by event logic but shall not cause any indication on the control panel.

c. Security monitor points: the system shall provide means to monitor any point as a type security.

d. One-man walk test: the system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

e. Control by event functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector or monitor module shall support listing of up to 10 zones into its programmed zone map.

ff. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (such as a control module) can support a list of up to 10
zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-alarm or supervisory points shall not activate the general alarm zone.

gg. 1000 general zones: the system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

hh. 1000 logic equations: the system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or range operators that allow conditional i/o linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

ii. 10 trouble equations per device: the system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

kk. Control-by-time: a time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

ll. Multiple agent releasing zones: the system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone with four abort options to satisfy any local jurisdiction requirements.

mm. Alarm verification, by device, with timer and tally: the system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

nn. Secure/access operation: the system shall have the capability of configuring input modules to monitor status of door contacts or other security type sensors. These input modules shall be able to be commanded from the normally ‘secure’ state to an ‘access’ state. While in the secure state, the module will transmit alarm conditions to the controller, which shall be annunciated on the LCD and led displays. The modules shall be placed into the access state either through the LCD display or through predefined operator keys. While in the access state, all alarms from the module will be shunted. Placing the module into the access state shall cause a discrete led associated with the input point to flash, but no
other trouble or disable condition will be annunciated. Change from secure to access and reverse shall be transmitted to the central monitoring station on a per zone basis. Systems that cause or indicate a trouble or disable condition are unacceptable.

E. Central processing unit
1. The central processing unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the central processing unit.
2. The central processing unit shall contain and execute all control-by-event (including boolean functions including but not limited to AND, OR, NOT, ANYX, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.
3. The central processing unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
4. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment besides a standard laptop pc. Systems that require the use of external proprietary programmers or change of EPROMS are not acceptable.
5. Consistent with ul864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.
6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.
7. The CPU shall provide an eia-232 interface between the fire alarm control panel and the UL listed electronic data processing (EDP) peripherals.
8. The CPU shall provide two eia-485 ports for the serial connection to annunciation and control subsystem components.
9. The eia-232 serial output circuit shall be optically isolated to assure protection from earth ground.
10. The CPU shall provide one high-speed serial connection for support of network communication modules.
11. The CPU shall provide double pole relays for fire alarm, system trouble, supervisory, and security. The supervisory and security relays shall provide selection for additional fire alarm contacts.
a. The on-board CPU relays must be left in the normal mode upon job completion. Is not permitted to disable the alarm, trouble, or supervisory relays even if they are unused at job completion.

F. Display
1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
3. The system display shall provide a 640-character backlit alphanumeric liquid crystal display (LCD). It shall also provide eleven light emitting-diodes (LEDs) that indicate the status of the following system parameters: ac power, fire alarm, prealarm, security, supervisory, system trouble, other event, signals silenced, point disabled, controls active and CPU failure.
4. The system display shall provide a keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one master and nine user) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
5. The system display shall include the following operator control switches: acknowledge, signal silence, reset, drill, and lamp test. Additionally, the display interface shall allow scrolling of events by event type including, fire alarm, security, supervisory, trouble, and other events. A print screen button shall be provided for printing the event currently displayed on the 640-character LCD.

G. Loop (signaling line circuit) control module
1. The loop control module shall monitor and control a minimum of 254 intelligent addressable devices. This includes 127 intelligent detectors (ionization, photoelectric, or thermal) and 127 monitor or control modules.
2. The loop control module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. The loop control module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC loop shall be configured for NFPA Style 7 (Class A) circuit. Fault isolation modules shall be installed between each addressable SLC device to meet this requirement per the manufactures installation instructions. Systems which can not provide full loop loading in style 7 configurations are not acceptable.
4. The SLC interface board shall be able to drive an NFPA Style 7 twisted circuit up to 12,500 feet in length. The SLC interface shall also be capable of driving an NFPA
Style 7, no twist, no shield circuit up to 1,000 feet in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure.

5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC loop shall be isolated and equipped to annunciate an earth fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

H. Enclosures
1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.
4. The control unit shall be modular in design for ease of installation, maintenance, and future expansion.

I. Digital Voice command center (DVCC)
1. The digital voice command center (DVCC), located with the FACP or network annunciator, shall contain all equipment required for all audio control, telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control telephone circuit indication and control, digital voice units, microphone and main telephone handset.
   a. Function: the digital voice command center equipment shall perform the following functions:
      1) Operate as a supervised eight channel emergency voice communication system.
      2) Operate as a two-way emergency telephone system control center.
      3) Audibly and visually annunciate the active or trouble condition of every speaker circuit and telephone circuit.
      4) Audibly and visually annunciate any trouble condition of tone generators and digital voice units required for normal operation of the system.
      5) Provide all-call activities through activation of a single control switch.
      6) Provide automatic, digitally-recorded voice messages and tones which may be field-programmed. Digitally-recorded voice messages shall be standard *.wav files and shall be downloaded via a laptop computer.
b. The DVCC shall be modular in construction. The DVCC shall be capable of being field programmed without requiring the return of any components to the manufacturer and without requiring use of any specialized computers or other programming equipment.

c. The DVCC and associated equipment shall be protected against unusually high voltage surges or line transients.

d. The DVCC shall provide a “controls active” led indicating that the user has current control over the live paging system.

e. The DVCC shall have the ability to communicate with up to 32 digital amplifiers on the same digital audio loop. The digital audio loop shall be capable of up to eight (8) channels of evacuation messages and up to five (5) channels of two way fire fighter’s telephone simultaneous over the same circuit. The digital audio loop shall be capable of utilizing standard twisted pair wire, multi mode or single mode fiber optic cable. Systems that require a separate circuit for fire fighter’s telephone will not be accepted.

f. The DVCC must be integrated with the FACP and housed within the same enclosure. Separately housed audio command centers are not permitted.

J. Power supply

1. The main power supply shall operate on 120/240 VAC, 50/60 HZ, and shall provide all necessary power for the FACP.

2. The main power supply shall provide 9 amps of power to the CPU, using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.

3. The main power supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.

4. The main power supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

5. The main power supply shall be power-limited per ul864 requirements.

6. The main power supply shall communicate power supply, line voltage, battery status and charger status to the local LCD display. Any abnormal condition shall be annunciated and logged to the system alarm history log.

K. Field charging power supply (FCPS): the FCPS is a device designed for use as either a remote 24 volt power supply or used to power notification appliances.

1. The FCPS shall be available in two models offering either up to 6.0 amps (4.0 amps continuous) or 8.0 amps (6.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60-hour standby.
2. The field charging power supply shall have two input triggers. The input trigger shall be a notification appliance circuit (from the fire alarm control panel) or a relay. Four outputs (two style y or z and two style y) shall be available for connection to the notification devices.

3. The FCPS shall include an attractive surface mount backbox.

4. The field charging power supply shall include the ability to delay the ac fail delay per NFPA requirements.

5. The FCPS include power limited circuitry, per ul standards.

6. The FCPS shall use the same key type as the fire alarm control panel and fire command center. All keys on the system shall be keyed alike.

L. System circuit supervision

1. The FACP shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.

2. Transponder circuit supervision: transponders shall be designed such that they continuously scan all of their initiating and notification circuits. With normal communications between the FACP and the transponders, the transponders shall transmit initiating and notification circuit trouble conditions to the FACP for audible annunciation and printout. With or without communication with the FACP, the transponders shall supervise their circuits and annunciate any initiating circuit and notification circuit failures on LEDs located on the transponder.

3. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.

4. All speaker and emergency phone circuits shall be supervised for opens and shorts. Each transponder speaker and emergency phone circuit shall have an individual on/off indication (green led).

M. Field wiring terminal blocks

1. To facilitate installation and service, all CPU wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the pc board are not acceptable.

N. Digital audio amplifiers

1. The digital audio amplifiers will provide audio power (@70 volts RMS) for distribution to up to four speaker circuits per amplifier.

2. Multiple audio amplifiers may be mounted in the transponder cabinet or in the main fire alarm control panel, either to supply incremental audio power, or to function as an automatically switched backup amplifier.
3. The audio amplifier shall provide the following controls and indicators:
   - normal condition led
   - brownout led
   - battery trouble led
   - amplifier trouble led

4. The digital audio amplifier shall include an integral power supply and battery charger. The battery charger shall be capable of charging batteries from twelve (12) to twenty-six (26) ah batteries. The digital audio amplifier shall be able to share batteries with other equipment. The on-board battery charger shall be disabled in this scenario.

5. The digital audio amplifier shall inherently supervise up to four (4) speaker circuits without the need for external control modules or switching relays. Speaker circuit selection shall be programmable through the laptop programmer.

6. The digital audio amplifier shall be capable of providing up to fifty (50) watts of power at 70 VRMS. Each speaker circuit must individually capable of providing the maximum capacity of the amplifier.

7. The digital audio amplifier shall supervise and control one fire fighter’s telephone riser.

8. The digital audio amplifier shall communicate to the digital voice command center (DVCC) via a digital audio loop (dal). The digital audio amplifiers shall be capable of supporting wire, single mode fiber optic cable or multi-mode fiber optic cable. The communication interface shall be integrated directly into the DAA. Systems requiring communication converters from wire to fiber shall not be acceptable.

9. The digital audio amplifier shall store a two (2) minute emergency backup message that can be configured to play whenever the dal is disrupted. This emergency message must be totally independent of the DVCC.

10. The digital audio amplifier shall be capable of accepting low level auxiliary input for the purpose of playing background music.

O. Digital voice command (DVC - prerecorded voice)/speaker control
1. Each initiating zone or intelligent device shall interface with an emergency voice stem capable of transmitting a prerecorded voice message to all speakers in the building.
2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers.
3. A built-in microphone shall be provided to allow paging through speaker circuits.
4. When fire fighter’s telephones are used, an optional telephone shall be installed at the DVCC for communication with remote telephones.
5. The message generator shall provide a system paging capability from telephone circuits.
6. The DVC shall have the following indicators to allow for proper operator understanding and control:
   - trouble
The DVC shall have the following pre-configured controls and switches:
- all call
- Page active evac areas
- Page inactive areas
- Page active alert areas
- Enable telephone page

The DVC shall have a minimum of twenty-four programmable switches which can be configured for the following functions:
- Speaker circuit or audio zone selection
- Telephone circuit or zone selection
- Custom message selection/activation

The DVC shall be capable of storing up to thirty-two (32) minutes of digital audio message segments. These segments may be linked together to form message sequences. Re-using of message sequences shall not affect the message capacity of the system. The messages shall be standard *.wav format and downloadable via a laptop programmer.

The DVC shall have the ability to communicate with up to thirty-two (32) digital audio amplifiers via wire, single mode or multi mode fiber.

The DVC shall provide an optional traditional low level audio output for retrofit systems. This low level audio option shall simultaneously provide up to four low level audio circuits which can be individually programmed for separate messages.

The DVC shall have the ability to communicate with other DVCs on a network. Messages from one DVC shall be able to be played on speaker circuits of other DVCs. DVCs shall be able to communicate with each other over the fire alarm network via wire or fiber. A separate audio network for this operation is not acceptable.

In a network scenario, multiple digital audio command centers shall be possible. A “controls active” led will illuminate to notify the user that the audio command center has control over other command centers.

The DVC shall be capable of accepting an auxiliary low level audio signal input for background music.

Speaker switches/indicators

The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
2. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

Q. Emergency two-way telephone control switches/indicators
   1. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
   2. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

R. Printer
   1. Printers shall be of the automatic type, printing code, time, date, location, category, and condition.
   2. The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table and U, listed for use with the XLS3000. The printer shall communicate with the control using an interface complying with electrical industries association standard EIA-232D. The printer power shall be 120 vac @ 60 hz.
   3. Thermal printers are not acceptable.

S. System expansion: design the main FACP and transponders so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.

T. Field programming
   1. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
   2. All field defined programs shall be stored in non-volatile memory.

U. Specific system operations
   1. Smoke detector sensitivity adjust: means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard. Sensitivity range shall be within the allowed UL window.
   2. Alarm verification: each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn-on. Alarm verification shall not require any
additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

3. System point operations:
   a. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad.
   b. System output points shall be capable of being turned on or off from the system keypad.

4. Point read: the system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
   a. device status.
   b. device type.
   c. custom device label.
   d. software zone label.
   e. device zone assignments.
   f. analog detector sensitivity.
   g. all program parameters.

5. System status reports: upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:

6. System history recording and reporting: the fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.

7. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

8. Automatic detector maintenance alert: the fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

9. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.
2.23 SYSTEM COMPONENTS

1. Fixed emergency telephone handset
   a. The telephone cabinet shall be painted red and clearly labeled emergency telephone. The cabinets shall be located where shown on drawings.
   b. The handset cradle shall have a switch connection such that lifting the handset off of the cradle shall send a signal to the fire command center which shall audibly and visually indicate its on-line (off-hook) condition.
   c. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line, per line, without degradation of the signal. The total system capacity shall be up to thirty-five (35) handsets active at one time, over 5 circuits. All five of these circuits shall transmit over the same single pair (wire or fiber).

2.24 BATTERIES AND EXTERNAL CHARGER

A. Battery
   1. Shall be 24 volt, sealed, lead-acid type. Two 12 volt batteries wired in series are acceptable.
   2. Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal ac power failure.
   3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.
   4. Batteries must be obtained from the manufacturer and the make and model must be listed for use with the FACP and all associated power supplies.

B. External battery charger
   1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt 50/60 hertz source.
   2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
   3. Shall have protection to prevent discharge through the charger.
   4. Shall have protection for overloads and short circuits on both ac and dc sides.

2.25 FIRE ALARM SYSTEM SEQUENCE OF OPERATION (INDIVIDUALLY CODED IFA)

ACTIVATION OF AN ALARM ON THE FIRE ALARM SYSTEM WILL:

PULL STATIONS
1. SOUND APPROPRIATE 4 ROUNDS OF NON-SILENCABLE INDIVIDUAL CODES THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMINATE RED LED AT FIRE ALARM CONTROL PANEL.
4. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD SCREEN.
5. ACTIVATE ALERT SOUNDER AT FACP.
6. ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM
   • WITH EXCEPTION OF CRITIC CARE UNITS WHICH WILL SHUTDOWN ON ALARM FOR THAT UNIT
7. TRANSMIT AN PULL ALARM POINT TO CENTRAL OFFICE

SMOKE & DUCTS
1. SOUND APPROPRIATE 4 ROUNDS OF (10-1) NON-SILENCABLE CODE THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMINATE RED LED AT FIRE ALARM CONTROL PANEL.
4. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD ACTIVATE ALERT SOUNDER AT FACP
5. ACTIVATE SMOKE ALARM BELL AT FACP
6. ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM
7. TRANSMIT AN SMOKE ALARM POINT TO CENTRAL OFFICE
8. ACTIVATE ELEVATOR RECALL UPON ACTIVATION OF ELEVATOR LOBBY, EMR SMOKE DETECTORS AND WATERFLOW DEVICES.

HEAT
1. SOUND APPROPRIATE 4 ROUNDS OF (10-3) NON-SILENCABLE CODE THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMINATE RED LED AT FIRE ALARM CONTROL PANEL.
4. DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD ACTIVATE ALERT SOUNDER AT FACP
5. ACTIVATE SMOKE ALARM BELL AT FACP
6. ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM
7. TRANSMIT AN SMOKE ALARM POINT TO CENTRAL OFFICE

WATERFLOW
1. SOUND APPROPRIATE 4 ROUNDS OF (10-2) NON-SILENCABLE TEMPORAL CODE THROUGHOUT PER NYC CODE.
2. FLASH ALL STROBE LIGHTS THROUGHOUT BUILDING
3. ILLUMINATE RED LED AT FIRE ALARM CONTROL PANEL.
4. **DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD ACTIVATE ALERT SOUNDER AT FACP**
5. **ACTIVATE WATER-FLOW ALARM BELL AT FACP**
6. **ACTIVATE FAN / DAMPER SHUTDOWN THROUGHOUT BUILDING OF ALARM**
7. **TRANSMIT AN WATERFLOW ALARM POINT TO CENTRAL OFFICE**
8. **ACTIVATE ELEVATOR RECALL UPON ACTIVATION OF ELEVATOR\EMR SMOKE DETECTORS AND WATERFLOW DEVICES.**

**UPON ANNUNCIATION OF ANY TROUBLE CONDITION, THE FIRE ALARM SYSTEM WILL:**
1. **DISPLAY ALPHANUMERIC MESSAGE DESCRIBING LOCATION OF ALARM CONDITION AT FACP, REMOTE ANNUNCIATOR & GRAPHIC ANNUNCIATOR LCD**
2. **ACTIVATE TROUBLE SOUNDER ON FACP.**
3. **ILLUMINATE YELLOW LED AT FIRE ALARM CONTROL PANEL.**
4. **ACTIVATE 6” TROUBLE BELL AT FACP**
5. **TRANSMIT A TROUBLE POINT TO CENTRAL OFFICE**

END OF SECTION 283111
4. Plumbing
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### PLUMBING

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PLUMBING GENERAL PROVISIONS
SECTION 220000 - PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 DEFINITIONS

A. "Provide": to supply, install, and make complete, safe, and operable, the particular work referred to unless specifically indicated otherwise.

B. "Install": to erect, mount, and make complete with all related accessories.

C. "Furnish" or "supply": to purchase, procure, acquire, and deliver complete with related accessories.

D. "Work": labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.

E. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and all related accessories.

F. "Wiring": raceway, fittings, wire, boxes and all related accessories.

G. "Indicated," "shown," or "noted": as indicated, shown, or noted on drawings or specifications.

H. "Similar" or "equal": of base bid manufacture, equal in quality materials, weight, size, performance, design, and efficiency of specified product, conforming with "Base Bid Manufacturers."

I. "Reviewed" "satisfactory," "accepted," or "directed": as reviewed, satisfactory, accepted, or directed by Architect and/or Engineer.

J. "Motor Controllers": manual or magnetic starters with or without switches, individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.
K. "Control or Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, flow, operation of equipment.

L. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

M. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

N. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

O. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

P. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

Q. The following are industry abbreviations for plastic materials:

1. **ABS**: Acrylonitrile-butadiene-styrene plastic.
2. **CPVC**: Chlorinated polyvinyl chloride plastic.
3. **NP**: Nylon plastic.
4. **PE**: Polyethylene plastic.
5. **PVC**: Polyvinyl chloride plastic.

R. The following are industry abbreviations for rubber materials:

1. **CR**: Chlorosulfonated polyethylene synthetic rubber.
2. **EPDM**: Ethylene propylene diene terpolymer rubber.

1.3 WORK INCLUDED
A. The work covered by this section includes the construction described in the Contract Documents including all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work includes, but is not limited to the following:

3. Natural Gas System
4. Piping, Valves and Fittings
5. Water Meters and Backflow Prevention Devices
6. Insulation.
7. Domestic Water Heaters.
8. Pumps.
9. Pressure Tanks.
10. Identification System.
11. Excavation and Backfill.
13. Hangers, Supports and Guides.
15. Electric Motor Controllers.
18. Rigging of Equipment.
19. Furnishing access Doors and Frames to be installed by the General Contractor.

20. Fire Stopping for Pipe Penetration.

21. Pipe Penetration and Drains Counterflashing.

22. Concrete Pads for Equipment.


24. Wiring between Water Meter Totalizer and Remote Reading Device.

B. Related Work not Included in this Division but Specified Elsewhere

1. Fire alarm wiring.

2. Finish painting, except for prefinished equipment or as otherwise specified.

3. Concrete work, except equipment inertia and floating bases.

4. Base flashing for piping and drains.

5. Toilet accessories.


7. Power wiring for motors and motor controllers.

8. Installation of access doors and frames.

1.4 COORDINATION OF WORK

A. The plumbing drawings show the general arrangement of piping and appurtenances. Follow these drawings as closely as the actual construction will permit. Conform the plumbing work to the requirements shown on the drawings. Provide offsets, fittings, and accessories, which may be required but not shown on the drawings. Investigate the site, structural and finish ground conditions affecting the work, and arrange the work accordingly. Provide such work and accessories as may be required to meet such conditions.

B. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.
C. Carefully check space requirements with other trades to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings.

D. Transmit to other trades all information required for work to be provided under their sections, in ample time for installation.

E. Wherever work interconnects with work specified of other trades, coordinate with the General Contractor to insure that all necessary information is presented so that all the necessary connections and equipment may be properly installed. Identify all items (valves, piping, equipment, etc.) in order that the General Contractor know where to install access doors and panels.

F. Consult with other trades regarding equipment so that, wherever possible, motors, motor controls, pumps and valves are of the same manufacturer.

G. Furnish and set all sleeves for passage of pipes and conduits through structural masonry and concrete walls and floors and elsewhere as will be required for the proper protection of each pipe passing through building surfaces.

H. Provide required supports and hangers for piping and equipment, designed so as not to exceed allowable loadings of structures.

I. Examine and compare the contract drawings and specifications with the drawings and specifications of other disciplines, and report any discrepancies between them to the General Contractor and obtain from him written instructions for changes necessary in the work of this Section. Install and coordinate the work of this section in cooperation with installing interrelated work. Before installation, take proper provisions to avoid interferences. All changes required in the work of the contractor, caused by his neglect to do so, to be made by him at his own expense.

J. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale similar to that of the design drawings, prepared on tracing medium of the same size as contract drawings. With these layouts, coordinate the work with the work of the contractor. Such detailed work is to be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion, however, include a set of such drawings with each set of as-built drawings. When directed by the Engineer, submit drawings for review, clearly showing the work of this section and its relation to the work of other disciplines before commencing shop fabrication or erection in the field.
K. Before commencing work, examine all adjoining work on which this work is in any way dependent for perfect workmanship and report any conditions, which prevent performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

L. Provide required anchor bolts, sleeves, inserts and supports. Direct location of anchor bolts, sleeves, inserts and supports to insure that they are properly installed. Any expense resulting from the improper location or installation of anchor bolts, sleeves, inserts and supports to be paid for by the contractor.

M. Slots, chases, openings and recesses through floors, walls, ceilings, and roofs will be provided by the various trades in their respective materials. Properly locate such openings and be responsible for any cutting and patching caused by the neglect to do so.

N. Adjust location of pipes, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each pipe prior to fabrication.

1. Right-of-Way: Lines, which pitch has the right-of-way over those that do not pitch, i.e., plumbing drains. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.

2. Make offsets, transitions and changes in direction in pipes as required to maintain proper head room and pitch on sloping lines whether or not indicated on the drawings. Furnish and install all traps, air vents, drains, etc., as required to affect these offsets, transitions and changes in direction.

O. Install all plumbing work to permit the removal (without damage to other parts) of water heaters and all other equipment requiring periodic replacement or maintenance. Arrange pipes and equipment to permit access to valves, cocks, starters, motors, and control components, and to clear the openings of swinging doors and access panels.

P. Provide access panels in equipment as required for inspection and maintenance of internal parts, etc.

Q. The contractor shall coordinate his work with the work of other trades.

R. Coordinated Composite Drawings
1. The Contractor shall prepare full coordinated composite drawings for the mechanical, electrical and fire protection trades. The Contractor shall overlay each trade’s work (in separate colors) on a sepia set of sheetmetal drawings. All conflicts and potential conflicts shall be clearly identified on the sepia sheetmetal drawings. This shall include but not be limited to conflicts with lights, equipment, piping, ductwork and supports of other trades, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trades, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trade attend a weekly job site coordination meeting in the Contractor’s field office. All trades shall resolve conflicts at these meetings and sign off each sepia sheetmetal drawing indicating acceptance and satisfactory resolution to all conflicts. All conflicts that cannot be resolved shall be brought to the attention of the Engineer for resolution.

1.5 USE OF SITE AND LOAD LIMITATIONS

A. The contractor shall review all available data on the location and types of pipelines and other underground utilities. The contractor shall not operate equipment over the facilities and shall take care not to damage them or otherwise impair their use. The contractor shall make investigation to verify the location of these facilities before proceeding with construction and/or operations in their vicinity.

1.6 CONTRACTOR’S RESPONSIBILITY FOR EVALUATION

A. The Engineer and Owner make no representations, regarding the character or extent of the subsoils, water levels, existing structural, mechanical and electrical installations, above or below ground or other subsurface conditions which may be encountered during the Work. The contractor must make his own evaluation of existing conditions, which may affect methods or cost of performing the Work, based on his own examination of the facility or other information. Failure to examine the drawings or other information shall not relieve the contractor of his responsibility for satisfactory accomplishment of the Work.

B. The locations of existing services are believed to be as indicated on the plans. The contractor shall verify the location of these services prior to commencing any work and notify the Engineer of any discrepancies.

1.7 ACCESS TO FIRE PROTECTION EQUIPMENT
A. The contractor shall not interfere with access to hydrants, fire exits, fire hose stations, fire extinguishers and fire alarm pull stations. In no case shall the contractor’s material or equipment be within twenty-five (25) ft of a hydrant or fire alarm pull station.

1.8 EQUIPMENT AND MATERIALS

A. If products and materials are specified or indicated on the drawings for a specific item or system, the contractor shall use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, in accordance with shop drawings.

B. All products and materials shall be new, clean, free of defects and free of damage and corrosion.

C. No permanent equipment shall be used to provide temporary services during construction.

D. Ship and store all products and materials in a manner which will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair.

E. Make certain that all materials selected directly, or by suppliers, conform to the requirements of the contract drawings and specification. Transmittal of such specifications and drawings, information to persons manufacturing and supplying materials to the project, and rigid adherence thereto, is the Contractor’s responsibility. Acceptance of a manufacturer’s name by the Engineer does not release the Contractor of the responsibility for providing materials, which comply in all respects with the requirements in the Contract Documents.

F. Applicable equipment and materials to be listed by Underwriters’ Laboratories and Manufactured in accordance with ASME, AWWA, or ANSI standards, and as approved by local authorities having jurisdiction.

G. Fully lubricate all equipment when installed and prior to final acceptance.

H. Do not operate water systems until piping has been tested and cleaned.

I. Secure equipment with bolts, washers and locknuts of ample size to support equipment. Embedded anchor bolts to have bottom plate and pipe sleeves. Grout all machinery set in concrete under the entire bearing surface. After grout has set, remove all wedges, shims and jack bolts and fill space with grout.
J. Locate valves, traps, access doors, etc., to be easily accessible, either in mechanical spaces or through access panels specified herein.

K. Follow manufacturers’ instructions for installing, connecting, and adjusting all equipment. Provide one copy of such instructions to the Engineer before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Provide all special valves, piping, wiring and accessories.

1.9 QUALITY ASSURANCE

A. Codes, Standards and Fees

1. Codes and Standards:

   a. Comply with all current governing codes, ordinances and regulations, UL and all other applicable codes.

   b. Comply with the requirements of the State adopted Building Code, and other agencies or authorities having jurisdiction over any part of the Work and secure all necessary permits.

   c. Where codes or standards are listed herein, the applicable portions apply.

   d. Plans, specifications, codes and standards are all minimum requirements. Where requirements differ, apply the more stringent.

   e. Should any change in plans or specifications be required to comply with governing regulations, the contractor is to notify the Engineer at the pre-bid meeting.

   f. The codes and standards listed in the Specifications can be obtained from the organizations listed as follows:

      1) OSHA Occupational Safety and Health Act
      2) ANSI American National Standard Institute, Inc.
      3) ASME American Society of Mechanical Engineers
      4) ASTM American Society for Testing and Materials
5) AWWA American Water Works Association

6) UL Underwriters Laboratories, Inc.

7) ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers

8) NEMA National Electrical Manufacturers Association

9) AIA American Insurance Association

10) AWS American Welding Society

11) ASA American Standards Association

12) IEEE Institute of Electrical and Electronics Engineers

13) NEC National Electrical Code

g. The particular specification will be identified by appropriate prefix and number only with the latest revision being applicable unless otherwise noted.

2. Fees

a. Pay all required fees.

b. Pay royalties or fees required in connection with the use of patented devices and systems.

B. Furnish all materials and equipment new, free from defects and with listings or labels of Underwriter's Laboratories, Inc. or other nationally approved testing laboratory.

C. All items of a given type shall be the product of the same manufacturer.

D. All materials and equipment shall be the product of manufacturers regularly engaged in their manufacture.

1.10 PERMITS AND FEES

A. In accordance with General Conditions (AIA Document 201) & Supplementary Conditions for Mechanical & Electrical Work.
B. The Contractor shall give necessary notice, file drawings and specifications with the department having jurisdiction, obtain permits or licenses necessary to carry out this work and pay all fees therefore. The Contractor shall arrange for inspection and test of any or all parts of the work if so required by authorities and pay all charges for same. The Contractor shall pay all costs for, furnish to the Owner before final billing, all certificates necessary as evidence that the work installed conforms with all regulations where they apply to this work.

C. This contractor shall prepare or hire the necessary consultants to prepare and file all plans, calculation, forms, etc.. required for filing with all agencies required for this work including but not limited to The DEP (Department of Environmental Protection ), DEC (Department of Environmental Conservation, Bureau of Air Resources, EPA Environmental protection Agency, FDNY, etc..

1.11 SPECIAL / CONTROLLED INSPECTION- NYC

A. Special inspection shall be provided by the owner. This contractor shall provide all required services to accomplish these inspections.

1.12 INSPECTIONS / TESTING

A. Independent testing and inspections shall be provided by this contractor who shall hire the inspector or testing agency

1.13 SHOP DRAWINGS

A. Prepare and submit detailed shop drawings for piping work and other distribution services, including locations and sizes of all openings in floor walls and roofs.

B. The work described in any shop drawing submission to be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. Each submitted shop drawing to include a certification that all related job conditions have been checked and that no conflict exists.

C. All drawings to be submitted sufficiently in advance of field requirements to allow ample time for checking. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts to be submitted as a package.
D. If submittals differ from the Contract Document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

E. Review of any submitted data or shop drawings for material, equipment apparatus, devices, arrangement and layout shall not relieve the contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details to efficiently perform the requirements and intent of the Work. Such review shall not relieve the contractor from responsibility for errors, omissions or inadequacies of any sort on submitted data or shop drawings.

F. Each shop drawing is to contain the job title, the names and phone numbers of the General Contractor and the contractor, references to the applicable design drawing or specification article, date and scale.

G. Within fifteen (15) days after award of Contract, submit for review, a list of all material and equipment manufacturers whose products are proposed, as well as names of all Subcontractors whom the General Contractor proposes to employ.

H. Within three (3) weeks after award of Contract, submit a list of all shop drawings, which will be submitted in the course of the project. List to show disposition of each item, including date of submission, review, and the like. List to be kept up-to-date throughout entire construction period.

I. Submit shop drawings and manufacturer’s data for the following items in accordance with the Contract Documents:

1. Coordinated, detailed shop layout drawings of all mechanical rooms, services and distribution systems, including plans, profiles and sections.

2. Details of piping supports, elbows, anchors and miscellaneous appurtenances.

3. Hangers, supports, inserts, anchors, guides and foundations.

4. Valves.

5. Pressure gauges and thermometers.

6. Corrosion protective coatings.
7. Equipment and piping layouts at 3/8 in. scale for the building.
8. Location and size of sleeves for openings in floors and walls.
10. Schedule of pipe and fittings, materials and application, valves, escutcheons, air vents, valve tags and schedules, strainers, and water specialties.
11. Pump system, including pumps, motors and controllers.
12. Building automation systems including descriptions, instruments, and alarms.
13. Flashing.
15. Pressure tanks and accessories.
17. Plumbing fixture and trim.
18. Other shop drawings and submittals as requested within the specification.

1.14 SAMPLES

A. Submit samples of all items with exposed finishes for review.
B. Allow sufficient time for consideration without interfering with job schedule.
C. Duplicate quality and finish to type to be supplied under contract.
D. Identify similar to shop drawings.

1.15 ELECTRONIC COPIES OF AKF DRAWINGS

A. If the contractor requires (.dwg) format, after preparation the drawings will be forwarded only upon receipt of signed acceptance of terms form. Permission from the architect must first be obtained for AKF to include the architectural background as reference. The contractor is to obtain the architects latest drawings directly from the architect.
B. These files are being issued for the convenience of the contractor and the contractor remains responsible for all contract requirements related to the normal shop drawing preparation process.

1.16 SUBMISSIONS:

A. Provide all coordination drawings and shop drawings in ‘AutoCad’ format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. If paper submissions are to be provided the following shall be adhered to.

1. Submissions 11 in. X 17 in. or smaller: If the submission is a catalog cut, then the contractor shall submit one original and one copy. Otherwise, they shall submit two copies. The architect will forward the original and one copy (two copies when no original is received) to the engineer. All catalog cuts shall be complete.

2. Submissions larger than 11 in. X 17 in.: submit two copies to the architect. The architect will forward to the engineer.

C. Indicate on each submission: project name and location, architect and engineer, item identification and approval stamp of prime contractor, subcontractor names and phone numbers, reference to the applicable design drawing or specification article, date and scale.

D. The work described in all shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job.

E. Each submitted shop drawing is to include a certification that all related job conditions have been checked and verified and that there are no conflicts.

F. All shop drawings are to be submitted to allow ample time for checking in advance of field requirements. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts shall be submitted as a package.

G. If submittals differ from the contract document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

1.17 AS-BUILTS AND EQUIPMENT OPERATION INSTRUCTIONS
A. Provide all coordination drawings and shop drawings in AutoCad format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. On completion and acceptance of work, this contractor shall furnish written instructions, equipment manuals and demonstrate to the owner the proper operation and maintenance of all equipment and apparatus furnished under this contract.

C. The contractor shall give one copy of the instructions to the owner and one copy to the engineer.

D. Final “as-built” drawings indicating as installed conditions shall be provided to the architect and engineer after completion of the installation.

1.18 START-UP

A. Properly lubricate all pieces of equipment.

B. Check and clean all pipes of dirt and debris, including strainers.

C. Prepare each piece of equipment in accordance with manufacturer’s installation instructions and have a copy at the equipment.

D. Fill and vent all water systems.

E. Check rotation on each motor.

F. Have representatives of each manufacturer present when hereinafter specified, so that equipment will be started up by manufacturer.

1.19 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Furnish access doors as required for operation and maintenance of concealed equipment, clean-outs, valves, shock absorbers, controls, etc., and coordinate their delivery with the installing trade.

B. Coordinate and prepare a location, size and function schedule of access doors required and deliver to the General Contractor and the Architect for review.
C. Doors shall be of a size required for operating and repacking valves, and shall be as manufactured by Karp Associates, Nystrom Inc., or Mifab.

D. Unless otherwise indicated, minimum size to be 18” x 18”.

E. Furnish color coded buttons or tabs to indicate location of valves or other equipment located above removable type ceilings where access doors are not required.

F. Access doors shall have a fire rating compatible with the wall construction in which they are located.

1.20 SYSTEM IDENTIFICATION

A. Piping:

1. All piping, exposed or concealed shall be identified as to its service in accordance with OSHA and ANSI Standards by one of the following methods:

a. Installation of manufactured adhesive band type identification markers, similar to "Quick-Label" by W.H. Brady Company.

2. Piping identification markings shall be installed as follows:

a. In each room.

b. All valve locations.

c. At shaft walls.

d. Every 40 feet on continuous runs.

3. Valves:

a. Valves shall be identified by a tag system utilizing brass tags at 2 inch minimum diameter and attached to the valves using brass chain.

1) The new valve tag identification numbers shall be permanently added to all existing valve tag charts within the building.

4. Equipment:
a. Identify all controls such as motor starters not in motor control centers, float switches, and alarms.

1.21 OPERATING & MAINTENANCE INSTRUCTION

A. Prepare operating and maintenance instructions manual including operating instructions, maintenance instructions, manufacturer’s data, specific equipment data.

B. Provide an alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.

C. Provide operating instructions for complete system, including:
   1. Normal starting, operating, and shut-down
   2. Emergency procedures for fire or failure of major equipment
   3. Summer and winter special procedures
   4. Day and night special procedures

D. Provide maintenance instructions, including:
   1. Valve tag list and equipment tag list
   2. Proper lubricants and lubricating instructions for each piece of equipment, and date when lubricated
   3. Required cleaning, replacement and/or adjustment schedule

E. Provide manufacturer’s data on each piece of equipment, including:
   1. Installation instructions.
   2. Drawings and specifications.
   3. Parts list, including recommended items to be stocked.
   4. Complete wiring and temperature control diagrams.
5. Marked or revised prints locating all concealed parts and all variations from the original system design.

6. Test and inspection certificates.

F. Provide specific equipment data including, but not limited to, the following:

1. For Plumbing Systems:
   a. Pumps.
   b. Valves.
   c. Piping.
   d. Accessories.
   e. Pressure reducing valves.
   f. Water heaters.
   g. Water meters.
   h. Strainers.
   i. Toilet fixtures and supports.
   j. Toilet fixture trim.
   k. Flow measuring devices.
   l. Electric wiring.
   m. Pressure tanks.

2. For Automatic Control System:
   a. Drawings and description of system controlled.
   b. Sequence of operation for each system.
c. Data on components.

d. Wiring and piping, schematic any layout, for panels and panelboards.

e. System operating manual, including set points.

G. Provide instruction of operating personnel.

1. Instruct Owner's operating personnel in proper starting sequences, operation, shutdown, and maintenance procedures, including normal and emergency procedures.

2. Instruction to be by personnel skilled in operation of equipment. Instructions for major equipment to be by equipment manufacturers’ representatives.

3. Make arrangements to give instructions by system and not by building areas.

4. Provide five (5) instruction sessions not to exceed six (6) hours each.

5. Instructions on automatic controls to be by manufacturer’s representative.

H. Submittals

1. Shop Drawings: Submit three copies for review prior to final issuance.

2. Provide six (6) copies of each operation and maintenance manual.
   a. Manuals to be 8-1/2” x 11 size in hard-back, 3-ring loose leaf binders. Use more than one volume if required. Do not overfill binders.
   b. Manuals to be completed and delivered to the Engineer for approval at least 20 days prior to instruction of operating personnel.

3. Prepare separate manuals for the Plumbing system.

1.22 TOOLS FOR OPERATION, ADJUSTMENT AND MAINTENANCE

A. Deliver to Owner’s representative all special tools needed for proper operation, adjustment and maintenance of equipment.

1.23 RECORD DRAWINGS
A. The contractor shall maintain a complete set of “Record Drawings” reflecting an accurate dimensional record of all work. These drawings shall be marked up to show the precise location of concealed work and equipment, including concealed piping and valves and all changes and deviations in the plumbing work from that shown on the contract drawings. This requirement shall not be construed as authorization for the contractor to make changes in the layout or work without written definite instruction from the Architect or Engineer.

B. Record dimensions shall clearly and accurately delineate the work as installed; location shall be suitably identified by at least two dimensions to permanent structures.

C. The contractor shall stamp all “Record Drawings” and certify for correctness by signing and dating them.

D. Record drawings submitted to Owner shall consist of 1 set of mylars and 1 set of compact disk’s (CD’s) with all work provided on Autocad 2000 format.

E. Prior to final acceptance, contractor shall submit certified “Record Drawings” to the Architect/Engineer for review and make changes, corrections or additions as noted by Architect/Engineer. After this review, the drawing shall be delivered to the Owner.
EXPANSION FITTINGS AND LOOPS
FOR PLUMBING PIPING
SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rubber expansion joints.
   2. Flexible-hose expansion joints.
   3. Pipe bends and loops.
   4. Alignment guides and anchors.

1.2 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.3 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Metraflex, Inc.
   c. MG Piping Products Co.
   d. Tozen America Corp.

2. Spherical Type: Single or multiple spheres.
   a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F
   b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F
   c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F

3. Material: Buna-N.

B. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flexicraft Industries.
   b. Metraflex, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections.
   a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
   b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adsco Manufacturing, LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flexicraft Industries.
   d. Metraflex, Inc.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
   2. Expansion Plug: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
   1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
2. Design Mix: 5000-psi 28-day compressive strength.

END OF SECTION 220516
METERS AND GAGES FOR PLUMBING PIPING
SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

   1. Thermometers.
   2. Gages.
   3. Test plugs.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Trerice, H. O. Co.
   2. Weiss Instruments, Inc.
   3. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum, 9 inches long.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
3. Ernst Gage Co.
4. Trerice, H. O. Co.
5. Weiss Instruments, Inc.
6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK, Inc.; U.S. Gauge Div.
3. Ernst Gage Co.
4. Trerice, H. O. Co.
5. Weiss Instruments, Inc.
6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry or liquid-filled type, drawn steel or cast aluminum, 6-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Window: Glass.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

END OF SECTION 220519
GENERAL-DUTY VALVES FOR PLUMBING PIPING
SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze lift check valves.
2. Bronze swing check valves.
3. Iron swing check valves.
4. Iron swing check valves with closure control.
5. Iron, grooved-end swing check valves.
7. Bronze gate valves.
8. Iron gate valves.
10. Chainwheels.

1.2 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.
PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Grooved: With grooves according to AWWA C606.
   4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

I. NSF Compliance: NSF 61 for valve materials for potable-water service
2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hammond Valve.
   b. NIBCO INC.
   c. Stockham Valves
   d. Conbraco Industries, Inc.; Apollo Valves.

2. Description:

   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   b. Hammond Valve.
   c. NIBCO INC.
   d. Stockham Valves

2. Description:

   b. SWP Rating: 150 psig
   c. CWP Rating: 600 psig
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.3 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   b. Hammond Valve.
   c. NIBCO INC.
   d. Stockham Valve

2. Description:

   a. Standard: MSS SP-80, Type 2.
   b. CWPRating: 200 psig
   e. Ends: Threaded.
   f. Disc: NBR, PTFE, or TFE.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Stockham Valves
   b. Hammond Valve
   c. Conbraco Industries, Inc Apollo Valves
   d. NIBCO INC.
2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.

B. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc Apollo Valves
      b. Stockham Valves
      c. NIBCO INC.
      d. Hammond Valve

   2. Description:
      a. Standard: MSS SP-80, Type 4.
      b. CWP Rating: 300 psig.
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: PTFE or TFE.

2.5 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc Apollo Valves
      b. Stockham Valves
      c. NIBCO INC.
      d. Hammond Valve

   2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Stockham Valves
   b. NIBCO INC.
   c. Conbraco Industries, Inc Apollo Valves
   d. Hammond Valve

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 500 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.

2.6 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc Apollo Valves
   b. Stockham Valves.
   c. Hammond Valve
   d. NIBCO INC.

2. Description:
2.7 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Tyco Fire Products LP; Grinnell Mechanical Products.
   b. Victaulic Company.

2. Description:

   a. CWP Rating: 300 psig.
   c. Seal: EPDM.
   d. Disc: Spring-operated, ductile iron or stainless steel.

2.8 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hammond Valve.
   b. NIBCO INC.

2. Description:

   b. CWP Rating: 200 psig.
d. Style: Compact wafer.
e. Seat: EPDM.

B. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Val-Matic Valve & Manufacturing Corp.
   b. Crispin Valve

2. Description:
   b. CWP Rating: 300 psig.
   d. Style: Globe, spring loaded.
   e. Ends: Flanged.
   f. Seat: EPDM.

C. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hammond Valve.
   b. NIBCO INC.
   c.

2. Description:
   b. CWP Rating: 400 psig.
   d. Style: Compact wafer, spring loaded.
   e. Seat: EPDM.

2.9 BRONZE GATE VALVES

A. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc Apollo Valves
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. NIBCO INC.
   d. Hammond Valve Company

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded or solder joint.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc Apollo Valves
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. NIBCO INC.
   d. Hammond Valves

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.
2.10 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc Apollo Valves
   b. Crane Valve Group; Stockham Division.
   c. NIBCO INC.
   d. Hammond Valve

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

B. Class 250, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. NIBCO INC.
   d. Hammond Valves

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 500 psig.
   c. Body Material: ASTM A126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.
2.11 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. NIBCO INC.
   d. Hammond Valve

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: PTFE or TFE.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.

B. Class 150, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. NIBCO INC.
   d. Hammond Valve

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 300 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: PTFE or TFE.
   g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.12 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Babbitt Steam Specialty Co.
2. Trumbull Industries.
3. Stockham
4. NIBCO.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball butterfly and plug valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve.

2.13 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, or gate valves.
2. Throttling Service: Globe valves.
3. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with disc.
   b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
   c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 3 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 4 and Larger: Flanged ends.
3. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

2.14 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with bronze trim.
   3. Bronze Lift Check Valves: Class 125, nonmetallic disc.
   4. Bronze Swing Check Valves: Class 150, nonmetallic disc.
   5. Bronze Gate Valves: Class 150, RS.

2.15 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller:
   1. Bronze Angle Valves: Class 150, nonmetallic disc.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 150, nonmetallic disc.
   4. Bronze Globe Valves: Class 150, nonmetallic disc.

B. Pipe NPS 4 and Larger:
   1. Iron Valves OS&Y flanged ends.
   2. Iron Swing Check Valves: Class 250, metal seats.
   3. Iron, Grooved-End Swing Check Valves: 300 CWP.
   4. Iron, Center-Guided Check Valves: Class 125 Class 150 Class 250 Class 300, globe, resilient seat.
   5. Iron Gate Valves: Class 125 Class 250, .

2.16 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
   4. Bronze Gate Valves: Class 125, RS.
B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
4. Iron, Grooved-End Swing Check Valves: 300 CWP.
5. Iron Gate Valves: Class 125, OS&Y.

END OF SECTION 220523
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.3 QUALITY ASSURANCE


B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code-Steel."
3. AWS D1.4, "Structural Welding Code-Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND supports

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   2. Carpenter & Paterson, Inc.
   3. ERICO/Michigan Hanger Co.
   5. Grinnell Corp.
   7. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
4. Thomas & Betts Corporation.
5. Tolco Inc.
6. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer’s standard finish unless bare metal surfaces are indicated.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMHAL-HANGER SHIELD INSERTS
A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.
C. Insulation-Insert Material for Cold and Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate vapor barrier.
D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS
A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. Masterset Fastening Systems, Inc.
   d. MKT Fastening, LLC.
   e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.6 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:
   a. MIRO Industries.
D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:
   a. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:

2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.
2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

END OF SECTION 220529
HEAT TRACING FOR PLUMBING PIPING
SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

1.2 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.


C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

1.5 FIELD QUALITY CONTROL

A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

1. Test cables for electrical continuity and insulation integrity before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

C. Remove and replace malfunctioning units and retest as specified above.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Raychem; a division of Tyco Thermal Controls.
2. Heat Timer

C. Heating Element: Pair of parallel No. 16AWG, nickel-coated stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Stainless-steel braid, and polyolefin outer jacket with UV inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F

G. Maximum Exposure Temperature (Power Off): 185 deg F

H. Maximum Operating Temperature: 300 deg F

I. Capacities and Characteristics:
   2. Piping Diameter: Line Size
   3. Number of Parallel Cables: As required
   4. Spiral Wrap Pitch: Per manufacturer’s recommendations
   5. Volts: 120, 208, 240, 277 or 480 V.
   6. Phase:
   7. Hertz:

2.2 CONTROLS

A. Pipe-Mounting Thermostats for Freeze Protection:
   1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F
   2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
   3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 22 Section "Identification for Plumbing Piping and Equipment."
C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.4 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer’s written recommendations using cable protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Division 22 Section "Plumbing Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

2.5 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 220533
SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Seismic snubbers.
12. Restraining braces and cables.
13. Steel vibration isolation equipment bases.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: C
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I, II, or III.
   a. Component Importance Factor: 1.0 or 1.5
   b. Component Response Modification Factor: 1.5, 2.5, 3.5 or 5.0
   c. Component Amplification Factor: 1.0 or 2.5

3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
4. Design Spectral Response Acceleration at 1-Second Period:
1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ace Mountings Co., Inc.
2. Isolation Technology, Inc.
5. Vibration Eliminator Co., Inc.
7. Vibration Mountings & Controls, Inc.
B. Pads Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene. Use drawing designation and coordinate with the Plumbing Vibration-Control and Seismic-Restraint Device Schedule on Drawings.

C. Mounts Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.

3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
New York Presbyterian Hospital  
Engineering Design Standards  
March, 2015

6. **Top Plate and Adjustment Bolt:** Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. **Restrained Spring Isolators Freestanding,** steel, open-spring isolators with seismic or limit-stop restraint.

1. **Housing:** Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. **Restraint:** Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. **Outside Spring Diameter:** Not less than 80 percent of the compressed height of the spring at rated load.
4. **Minimum Additional Travel:** 50 percent of the required deflection at rated load.
5. **Lateral Stiffness:** More than 80 percent of rated vertical stiffness.
6. **Overload Capacity:** Support 200 percent of rated load, fully compressed, without deformation or failure.

G. **Housed Spring Mounts >:** Housed spring isolator with integral seismic snubbers.

1. **Housing:** Ductile-iron or steel housing to provide all-directional seismic restraint.
2. **Base:** Factory drilled for bolting to structure.
3. **Snubbers:** Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. **Elastomeric Hangers:** Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. **Spring Hangers:** Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. **Frame:** Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. **Outside Spring Diameter:** Not less than 80 percent of the compressed height of the spring at rated load.
3. **Minimum Additional Travel:** 50 percent of the required deflection at rated load.
4. **Lateral Stiffness:** More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.
2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Isolation Technology, Inc.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Steel Base Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.


1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
2.3 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connectionshanger rod.

F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts
with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

A. Finish: Manufacturer’s standard prime-coat finish ready for field painting.

B. Finish: Manufacturer’s standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

END OF SECTION 220548
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.


C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.
2. Valve-tag schedule(s) shall be mounted in locations to be directed by Owner. Mountings shall be in a metal frame with plexi-glass (clear) cover.

2.6 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section Interior Painting

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer’s option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

   1. Identification Paint: Use for contrasting background.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

2.7 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
B. Valve-Tag Application Schedule: Tag valves shall be 2” round, medical gases shall be 2” square.

END OF SECTION 220553
PLUMBING INSULATION
SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.

2. Insulating cements.
3. Adhesives.
4. Sealants.
5. Factory-applied jackets.
6. Field-applied jackets.
7. Tapes.
8. Securements.
9. Corner angles.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
1.3 COORDINATION

A. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

B. Coordinate installation and testing of heat tracing.

1.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

   2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, locations of threaded strainers, locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000 Pipe Insulation.
   c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS


1. Products: Subject to compliance with requirements, provide one of the following:
   a. Insulco, Division of MFS, Inc.; Triple I.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA Inc.; Aeroseal.
   b. Armacell LCC; 520 Adhesive.
   c. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.


1. Products: Subject to compliance with requirements, provide one of the following:
   b. ITW TACC, Division of Illinois Tool Works; S-90/80.
   c. Marathon Industries, Inc.; 225.
d. Mon-Eco Industries, Inc.; 22-25.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); 739, Dow Silicone.
   e. Speedline Corporation; Speedline Vinyl Adhesive.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster Products Corporation, H. B. Fuller Company; 95-44.
   b. Marathon Industries, Inc.; 405.
   c. Mon-Eco Industries, Inc.; 44-05.
   d. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
   b. Insert manufacturer’s name; product name or designation.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F
2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.
C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
   a. Factory cut and rolled to size.
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.
2.9 FIRE WRAP

A. Provide 3µ fire wrap for all piping required to meet fire resistance rating.

2.10 PLENUM WRAP

A. Provide 3µ Plenum wrap for all piping required to meet fire smoke density requirements.

2.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
   1. Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Storm Water and Overflow:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1/2 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:
1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

2.12 Piping Exposed to Outdoors and Pipes Subject to Freezing: Cover any piping subject to freezing with an additional layer of 2" glass fiber insulation of the same finish as specified for the particular service when not subject to freezing, but not less than 3" total thickness.

2.13 For heat-traced piping, insulation must be sized to accommodate electric cable. Cover with an aluminum jacket, as specified for piping exposed to the weather.

END OF SECTION 220700
DOMESTIC WATER PIPING
SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Encasement for piping.
   4. Flexible connectors.
   5. Escutcheons.
   6. Sleeves and sleeve seals.
   7. Wall penetration systems.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to SEI/ASCE 7.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

C. Lead-free Certifications: Provide manufacturer’s certification that valves, water sub-meter etc. in contact with the potable water meet the requirements of the Reduction of Lead in Drinking Water Act effective Jan 4, 2014.

1.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
5. Grooved-Joint Copper-Tube Appurtenances:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Victaulic Company.
      2) Anvil Manufacturing, Gruvlok
   b. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
   c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

B. Soft Copper Tube: ASTM B 88, Type L water tube, annealed temper.


2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
   a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dresser, Inc.; Dresser Piping Specialties.
      b. Ford Meter Box Company, Inc. (The).
      c. Smith-Blair, Inc; a Sensus company.
      d. Viking Johnson; c/o Mueller Co.
2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   b. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:
   a. Pressure Rating: 150 psig at 180 deg F.
   b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Factory-fabricated, bolted, companion-flange assembly.
   b. Pressure Rating: [150 psig] [175 psig minimum]
   c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Calpico, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.

2. Description:
   a. Galvanized-steel coupling.
   b. Pressure Rating: 300 psig at 225 deg F.
   c. End Connections: Female threaded.
   d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Precision Plumbing Products, Inc.
   b. Victaulic Company.

2. Description:
   a. Electroplated steel nipple complying with ASTM F 1545.
   b. Pressure Rating: [300 psig at 225 deg F].
   c. End Connections: Male threaded or grooved.
   d. Lining: Inert and noncorrosive, propylene.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mercer Rubber Co.
2. Metraflex, Inc.
3. Universal Metal Hose; a Hyspan company
B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum [200 psig] [250 psig].
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum [200 psig] [250 psig].
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.8 ESCUTCHEONS
A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
D. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
E. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
F. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.9 SLEEVES
A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with setscrews.

2.10 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Calpico, Inc.
2. Metraflex, Inc.
3. Thunderline.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Plastic.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.11 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
F. Install domestic water piping level and plumb.

G. Rough-in domestic water piping for water-meter installation according to utility company’s requirements.

H. Install seismic restraints on piping. Comply with requirements in Division 22 Section “Vibration and Seismic Controls for Plumbing Piping and Equipment” for seismic-restraint devices.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping adjacent to equipment and specialties to allow service and maintenance.

M. Install piping to permit valve servicing.

N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section “Meters and Gages for Plumbing Piping” for pressure gages.

S. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section “Domestic Water Pumps” for thermostats.
2.12 Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing.

2.13 Provide shock arrestors for flush valve fixtures and quick closing valves.

2.14 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building service piping, NPS 4 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K wrought-copper solder-joint fittings; and solder joints

E. Under-building-slab, domestic water, building-service piping, NPS 5 to NPS 8 and larger, shall be one of the following:
   1. Mechanical-joint, ductile-iron pipe; standard-pattern mechanical-joint fittings; and mechanical joints.

F. Aboveground domestic water piping, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L cast-copper solder-joint fittings; and soldered joints.

G. Aboveground domestic water piping, 4” and larger the following: may be used
   1. Hard copper tube, ASTM B 88, Type L cast- or wrought- copper solder-joint fittings; and brazed joints.
   2. Hard copper tube, ASTM B 88, Type L grooved-joint copper-tube appurtenances; and grooved joints may be used only with approval of FO and exposed to view.
2.15 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 3 and smaller. Use OS&Y gate valves with flanged ends for piping NPS 4” and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 and larger.
4. Drain Duty: Hose-end drain valves. Valve to be ¾” bronze ball valve.

B. Check valves 3” and smaller shall be bronze swing type.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116
SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Backflow preventers.
   5. Temperature-actuated water mixing valves.
   7. Outlet boxes.
   8. Hose stations.
   9. Hose bibbs.
  10. Wall hydrants.
  11. Drain valves.
  12. Water hammer arresters.
  13. Air vents.
  15. Trap-seal primer systems.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

1.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

1.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; Model 35XL (Lead-Free) or comparable product by one of the following:
      a. Conbraco Industries, Inc
      b. FEBCO; SPX Valves & Controls.
   3. Size: NPS 1/4 to NPS 3 as required to match connected piping.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Chrome plated.
B. Hose-Connection Vacuum Breakers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; [Model BFP-8F] [Model BFP-9] or comparable product by one of the following:
   a. MIFAB, Inc.
   c. Woodford Manufacturing Company.
   d. 

5. Finish: Rough bronze.

C. Pressure Vacuum Breakers

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; [Model 720A] [Model 420XL (Lead-Free)] or comparable product by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts; a Watts Water Technologies company.

3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
5. Size: NPS 1/2 to NPS 2 (DN 15 to DN 50), as required to match connected piping.
6. Accessories:
   a. Valves: Ball type, on inlet and outlet.

D. 

E. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   c. Woodford Manufacturing Company.
   d. Zurn Plumbing Products Group; Wilkins Div.

5. End Connections: Threaded.
6. Finish: Chrome plated.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins: [Model 375XL (Lead-Free)] [Model 375A (Lead-Free)] [Model 375ST (Lead-Free)] [Model 375AST (Lead-Free)] or comparable product by one of the following:
   a. Ames Co.
   b. FEBCO; SPX Valves & Controls.

3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 maximum, through middle 1/3 of flow range.
5. Size:
6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

B. Double-Check Backflow-Prevention Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins: [Model 350XL (Lead-Free)] [Model 350] [Model 350A (Lead-Free)] [Model 350AST (Lead-Free)] [Model 450 (Lead-Free)] or comparable product by one of the following:
   a. Ames Co.
   b. FEBCO; SPX Valves & Controls.

3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

C. Dual-Check-Valve Backflow Preventers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; [Model 700XL (Lead-Free)] [Model 705 (Lead-Free)] [Model 700FP] or comparable product by one of the following:
   a. 
   b. FEBCO; SPX Valves & Controls.

3. Operation: Continuous-pressure applications.
4. Size: NPS ½, NPS ¾, NPS 1 or NPS 1-1/4.
5. Body: Bronze with union inlet.

D. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. FEBCO; SPX Valves & Controls.
   d. Wilkens

2. Standard: ASSE 1047 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
   a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
   c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

E. Double-Check, Detector-Assembly Backflow Preventers:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; [Model 350DA] [Model 350ADA] [Model 450DA] [Model 350ASTDA] or comparable product by one of the following:
   a. Ames Co.
   b. FEBCO; SPX Valves & Controls.
2. Standard: ASSE 1048 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
   a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
   b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

F. Hose-Connection Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Woodford Manufacturing Company.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; [Model 70XL (Lead-Free)] [Model 600XL (Lead-Free)] [Model NR3XL (Lead-Free)] [Model 500XLTYSBR (Lead-Free)] or comparable product by one of the following:
   a. Conbraco Industries, Inc.

4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ITT Industries; Bell & Gossett Div.
   b. NIBCO INC.
   c. Taco, Inc.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: bronze,
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Memory-Stop Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Div.
      d. NIBCO Inc.
   Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
   2. Pressure Rating: 400-psig minimum CWP.
   3. Size: NPS 2 or smaller.
   4. Body: Copper alloy.
   5. Port: Standard or full port.
   7. Seats and Seals: Replaceable.
   8. End Connections: Solder joint or threaded.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Powers; a Watts Industries Co.
      b. Symmons Industries, Inc.
   4. Type: Thermostatically controlled water mixing valve.
   5. Material: Bronze body with corrosion-resistant interior components.
   6. Connections: Threaded union inlets and outlet.
   7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting:
9. Tempered-Water Design Flow Rate:
10. Valve Finish: Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Powers; a Watts Industries Co.
   b. Symmons Industries, Inc.
4. Type: Exposed-mounting or Cabinet-type, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Tempered-Water Setting:
10. Tempered-Water Design Flow Rate:
11. Selected Valve Flow Rate at 45-psig Pressure Drop:
12. Pressure Drop at Design Flow Rate:
13. Valve Finish: Chrome plated
15. Cabinet: Factory-fabricated, stainless steel, for [recessed] [surface] mounting and with hinged, stainless-steel door.

C. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Powers; a Watts Industries Co.
   b. Symmons Industries, Inc.
2. Description: Factory-fabricated, [cabinet-type] [exposed-mounting], thermostatically controlled, water-mixing-valve assembly in [two] [three]-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.

7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.

8. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.


10. Selected Large Flow, Tempered Water Valve Size:

11. Tempered-Water Setting:

12. Unit Tempered-Water Design Flow Rate:

13. Unit Minimum Tempered-Water Design Flow Rate:

14. Selected Unit Flow Rate at 45-psig Pressure Drop:

15. Unit Pressure Drop at Design Flow Rate:

16. Unit Tempered-Water Outlet Size: end connection.

17. Unit Hot- and Cold-Water Inlet Size: end connections.

18. Thermostatic Mixing Valve and Water Regulator Finish: Chrome plated


D. Photographic-Process, Thermostatic, Water-Mixing-Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Powers; a Watts Industries Co.
   b. Symmons Industries, Inc.

2. Standard: ASSE 1017, thermostatically controlled water mixing valve made for precise, process-water temperature control.

3. Pressure Rating: 125 psig minimum, unless otherwise indicated.


5. Connections: Threaded inlets and outlet.

6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.

7. Cabinet: Factory-fabricated, stainless steel, for surface mounting; with controls and thermometer mounted on front.

8. Tempered-Water Setting:

9. Tempered-Water Design Flow Rate:


E. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Powers; a Watts Industries Co.

3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 90 deg F.
9. Tempered-Water Design Flow Rate: 0.5 gpm.

F. Primary Water Tempering Valves
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Holby Valve Co., Inc.

2. Standard: ASSE 1017, thermostatically controlled tempering valve, listed as tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
6. Inlets and Outlet: Threaded.
7. Selected Primary Water Tempering Valve Size:
8. Tempered-Water Setting:
9. Tempered-Water Design Flow Rate:
10. Pressure Drop at Design Flow Rate:
12. Cold-Water Inlet Size: end connection.

2.6 STRAINERS FOR DOMESTIC WATER PIPING
A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.

2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Guy Gray Manufacturing Co., Inc.
      c. Oatey.
      d. Symmons Industries, Inc.
      e. Watts Industries, Inc.; Water Products Div.

   3. Material and Finish: Enameled-steel or epoxy-painted-steel or plastic box and faceplate.
   4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
   5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
   6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
   7. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
   8. Drain Hose: One 48-inch-long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Oatey.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE STATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armstrong International, Inc.-Rada
2. Leonard Valve Company.
3. T & S Brass and Bronze Works, Inc.

B. Single-Temperature-Water Hose Stations:

2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
4. Body Material: Bronze
5. Body Finish: Rough bronze[, chrome plated].
6. Mounting: Wall, with reinforcement
7. Supply Fitting: NPS ½ or NPS ¾ gate, globe, or ball valve and check valve and NPS ½ or NPS ¾ copper, water tubing. Omit check valve if check stop is included with fitting.
8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet long.
10. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

C. Hot- and Cold-Water Hose Stations

2. Type Faucet: Thermostatic mixing valve.
7. Mounting: Wall, with reinforcement.
8. Supply Fittings: Two NPS ½ or NPS ¾ gate, globe, or ball valves and check valves and NPS ½ or NPS ¾ copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer’s standard, for service fluid, temperature, and pressure; 25 feet or 50 feet long.
11. Vacuum Breaker: Integral or factory-installed, non-removable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

D. Cold-Water and Steam Hose Stations
2. Type Faucet: Thermostatic mixing valve.
7. Mounting: Wall, with reinforcement or Floor, with stainless-steel pedestal.
8. Supply Fittings: Two NPS ½ or NPS ¾ gate, globe, or ball valves and check valves and NPS ½ or NPS ¾ copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer’s standard, for service fluid, temperature, and pressure; 25 feet long.
11. Vacuum Breaker: Integral or factory-installed, non-removable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

2.9 HOSE BIBBS

A. Hose Bibbs:

AKF
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Vacuum Breaker: Integral or field-installation, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   c. Watts Drainage Products Inc.
   d. Woodford Manufacturing Company.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze or Chrome plated.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze or Rough bronze.
12. Operating Keys(s): Two with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Tyler Pipe; Wade Div.
   c. Watts Drainage Products Inc.
   d. Woodford Manufacturing Company.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.
4. Operation: Loose key.
5. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
7. Outlet: Concealed.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze or Chrome plated.
11. Operating Keys(s): Two with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Woodford Manufacturing Company.
   d. Zum Plumbing Products Group; Light Commercial Operation.

2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

2. Pressure Rating: 400-psi minimum CWP.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.

2.12 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. PPP Inc.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
   f. Sioux Chief
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
B. Water hammer arrestors to be installed where quick closing valves are utilized.

C. Access doors to be installed at all water hammer arrestor locations

2.13 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. PPP Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Watts Industries, Inc.; Water Products Div.

5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

5. Material: Chrome-plated, cast brass.
2.14 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. PPP Inc.

2. Standard: ASSE 1044,

3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.

4. Cabinet: Recessed or Surface-mounting steel box with stainless-steel cover.

5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.


7. Number Outlets: Four to Eight


END OF SECTION 221119
DOMESTIC WATER PUMPS
SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:

1. Close-coupled, end suction.
2. Horizontal Split Case Pumps (Multi-Stage)
3. Duplex/Triplex Packaged Constant Pressure Booster Pumps
4. Duplex/Triplex Variable Speed Pumps

1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

A. Manufacturers:

1. AKF
2. American Marsh-Neptune Series
3. Federal Pumps

2.1 Provide a (duplex) (triplex) factory assembled, packaged, House Tank Fill (and Suction Tank Level Control) System. The system shall consist of pumps, motors, starters, controls, valves, piping and all components necessary to automatically maintain the level in the house (and suction) tank(s) and initiate alarms. System flow shall be 0 to ____ GPM, at a pressure of ____ PSIG, available suction pressure at the pump skid is ____ to ____ PSIG.

The system shall require suction and discharge pipe connections, interconnection with tank level controls and electrical power connection. The system shall have multi-tiered levels of redundancy for fail-safe operation: electronic, electro-mechanical, mechanical and manual.

2.2. PUMPS AND MOTORS

PUMP HEAD UP TO APPROXIMATELY 250' TDH
Close Coupled End Suction Pumps

Pumps shall be close coupled end suction type with cast iron casing, bronze impeller, bronze casing wear ring, steel shaft, bronze shaft sleeve, and mechanical seal with Ni-Resist seat, carbon washer, Buna flexible members, and 18-8 stainless steel spring. Pump specification shall be as follows:

<table>
<thead>
<tr>
<th>PUMP NO.</th>
<th>GPM</th>
<th>HEAD (FT.)</th>
<th>MIN. EFF.</th>
<th>MAX. SHUT-OFF (PSIG)</th>
<th>HP / RPM</th>
<th>MODEL WORKING PRESS. (PSIG)</th>
</tr>
</thead>
</table>

Each pump shall be close coupled to a _____ volt, 3 phase, 60 hertz motor, 1.15 S.F., ODP enclosure with grease lubricated bearings. Pumps shall be capable of operation at any point on their performance curves without overloading the motors and without the restriction of a minimum flow limit for satisfactory operation.

PUMP HEADS ABOVE APPROXIMATELY 250' TDH
Horizontal Split Case Pumps (Multi-Stage)
1. Pumps shall be multi-stage horizontally split case type with suction and discharge connections located on opposite sides in the lower half casing, allowing removal of the rotating element without disturbing the pipe connections.

2. Casings shall be cast iron free from blow holes, sand pockets, and other detrimental defects. Water passageways shall be smooth to permit maximum efficiency. Casing shall be capable of withstanding a hydrostatic test pressure 1.50% of the maximum pumping pressure under which the pump could operate at the design speed.

3. Impellers shall be cast bronze, single suction type. A pump having an equal number of stages shall have an equal number of impellers facing in opposite directions to obtain hydraulic balance. The impellers shall be balanced, keyed to the shaft and fixed in an axial position by shaft sleeves.

4. Bronze replaceable case wear rings shall provide close clearance to permit a minimum of recirculation. Case rings shall be shouldered in the casing to prevent axial movement and pinned to prevent rotation.

5. Pumps shall be designed so that first stage pressure plus suction pressure will be the maximum pressure on either stuffing box. Stuffing boxes shall be large and deep and shall hold a minimum of five rows of graphite impregnated packing and lantern ring. Packing glands shall be bronze and split for removal to facilitate repacking stuffing boxes. Gland bolts shall be the swing type.

6. Shafts shall be 416 stainless steel adequately sized for the loads transmitted. Shaft shall be threaded adjacent to both the first and second stage impeller hubs to allow axial adjustment of the impellers by means of threaded sleeves.

7. Shafts shall be protected throughout the stuffing box with 416 stainless steel shaft sleeves hardened to 350 Brinnell. They shall be designed to prevent leakage between the shaft and the shaft sleeve. The shaft sleeve shall be threaded to tighten against the impellers and locked in place with set screws.

8. Bearings shall be designed for minimum B-10 life of 20,000 hours. The outboard bearing shall be a duplex angular contact ball bearing. The inboard bearing shall be a single row radial type ball bearing.

9. Drain connections shall be provided at all low points in the pump volutes as well as at the drip pocket underneath the stuffing box. The volutes and interstage passages shall be provided with air vents for release of air from the casing.
10. Pumps shall be as follows:

<table>
<thead>
<tr>
<th>PUMP NO.</th>
<th>GPM</th>
<th>HEAD (FT.)</th>
<th>MIN. EFF.</th>
<th>MAX. SHUT-OFF (PSIG)</th>
<th>HP / RPM</th>
<th>MODEL-STAGES</th>
<th>WORKING PRESS. (PSIG)</th>
</tr>
</thead>
</table>

11. Each pump shall be driven through a flexible coupling by a 220 volt, 3 phase, 60 Hertz motor, 1.15 S.F., ODP enclosure with grease lubricated bearings. Each shall be provided with a coupling guard. Pumps shall be capable of operation at any point on their performance curves without overloading the motors and without the restriction of a minimum flow limit for satisfactory operation.

2.3. PACKAGING

1. All components shall be mounted on a structural steel base suitable for grouting. The contractor shall completely fill the base with grout prior to pump start-up.

2. Piping shall consist of flanged cast iron fittings and steel spool pieces having a fused epoxy coating inside and out conforming to FDA regulations for potable water, stainless steel or Type "L" copper. The piping shall be adequately supported independent of pump connections. It shall be arranged with adequate space for maintenance and to allow for removal of any pump without system shutdown. The piping shall be sized for a maximum velocity of 6 to 8 FPS.

3. Isolation valves shall be provided as follows:
   a. Suction and discharge of each pump Fleetport series 5001, flanged, full port ball type, having a positive shutoff rating which exceeds Class VI, 316 cast stainless steel body with stainless steel Teflon fused solid ball and stainless steel trim, 300 PSIG WP.

   b. System suction and system discharge headers, as complete system isolation valves, same as described for pump isolation.

4. Each pump shall be provided with a mechanical thermal safety purge valve which shall open and discharge water to drain should the pump become hot and reseat when the pump cools due to expansion and contraction of a permanently sealed wax
5. Diaphragm type, pump control and non-slam check valve with internal drop check, Singer Model 106-PG-HC-IDC-FPS, shall be installed on the discharge of each pump. The valve shall slowly open and provide a non-slam, drip tight, closure upon flow reversal. Materials of construction shall be 316 stainless steel, globe style body, stem, seat, disc retainer, guide bushing, spring and fasteners, ANSI Class 150 (300) flanges, 250 (600) PSIG maximum working pressure. Valve pilot lines shall be equipped with pilot line strainers, opening speed control and isolation ball valves.

b. Valves shall be designed for ease of assembly and maintenance and shall be completely serviceable in-line without need for special tools. Main valve bonnet shall have a removable cap for easy access to spring and upper bearing without having to remove the main valve bonnet or pilot system, valve stems shall have wrench flats.

c. In addition to the standard materials, these valves shall be specially constructed for operator convenience, serviceability and corrosion resistance with the following features:
   1) Position indicator with air vent valve for visual observation of operation
   2) Ball valves for pilot line strainer blowdown
   3) Ball valves at every pilot port to facilitate operational testing
   4) Oxy-Nitride coated stems for increased lubricity, resistance to mineral deposits and enhanced corrosion protection.

6. Controller mounted, 4-1/2" diameter, glycerin filled, pressure gauges shall be provided for indication of suction, system, and individual pump discharge pressures. All pressure sensing lines for gauges or pressure switches shall be copper factory piped with shut-off valves.

7. The pumps and all components on the discharge side of the pumps shall have a rated working pressure greater than pump shut-off head plus maximum suction pressure. The contractor shall pipe all purge valve discharge lines and, packing gland drains (separate from purge lines) to a floor drain.

2.4 LEVEL CONTROLS

1. The remote level indicating control panel shall be mounted as close as possible to the house tank in a heated, sheltered area. The panel shall be energized from a dependable local source, with 110-120 volt, single phase power and shall be equipped with a circuit breaker disconnect
switch, and power failure relay. The power failure relay shall activate a local alarm contact and a power failure alarm at the pump controller should the panel lose power. The control panel shall provide for visual indication of (house tank water level) (house tank and suction tank levels), automatic tank make-up, level alarms and pump shutdown by means of a primary electronic level control system and redundant systems of float switches, relays and control valves. It shall include the following:

a. circuit breaker disconnect switch

b. Logic control module with graphical HMI color touch screen.

c. 24 VDC transducer power supply

d. power on light with power failure relay circuits (120VAC, (SUCTION TANK ONLY 24VAC) & 24VDC)

f. indicating lights with lamp test feature.

g. active tank / compartment selector switch

h. 3 Position Valve selector switch - open, close, automatic

i. Visual indication and alarms for:
  • control power
  • high water level
  • low water level
  • high level safety shutoff valve open
  • high level safety shutoff valve closed
  • pump cut-off
  • back-up float circuit activated
  • low tank temperature

h. alarm horn with silencing push-button

i. field terminal connections for:
  • 110-120 VAC high level safety shutoff solenoid valve
  • high level safety shutoff valve position switch
  • 4-20 mA transducer input signal
  • 4-20 mA output signal for remote level indication by the Building Management System
  • 24 VDC back-up float switches
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

- low water cut-off of the domestic water pumps

j. All the above shall be prewired in a single NEMA 4, watertight / dust-tight gasketed enclosure with drip shield.

k. All fuses shall have a status indicating light which illuminates if a fuse is blown for quick trouble-shooting with use of a meter.

l. All auxiliary contacts shall be "Form C" (1-NO & 1-NC). All interconnecting wiring shall be made to a terminal strip.

m. All internal wiring shall be numbered corresponding to the wiring diagrams.

n. All connections to auxiliary contacts and control components, whether remote or panel mounted, shall be made to terminal strips.

o. The control panel shall bear the UL508 label of Underwriters Laboratories signifying that all work performed by the manufacturer is in compliance with the requirements of the Underwriters Laboratories. Approval of just the enclosure or electrical devices is unacceptable.

p. The controller shall be field interwired, by the electrical contractor, with the tank level controls, high water level safety shut off valves (and low water cutoff of the high zone booster, if any).

2. The logic level control module shall be a SCADA ready controller with bright color HMI interactive touch screen having a 7", high resolution display of not less than 800 x 480 pixels. The controller shall be an intelligent, modular unit, capable of data acquisition, local data processing, data logging, alarm management, alarm annunciation and communication. The device shall have multiple screens and multiple operator security password levels. The primary screen shall provide for a minimum of twenty-six (26) visual and touch status points. It shall graphically represent the physical house and suction tank system components, their real time status with visual color change indication, operational and alarm set points, including:
   - tank water level - graphic & digital (of each tank or compartment if multiple)
   - pump operation
   - pump elapsed run time and starts
   - high level safety shutoff valve operation
   - high water level alarm
   - low water level alarm
   - low water level pump cutoff
   - back-up active
   - tank water temperature - graphic & digital (house tank only)
• wind velocity - if connected to remote sensor
• time & date
• system designation

The same logic controller with color touch screen shall be located in the pump system control panel, either level controller shall function as the master or slave providing for system status, set point adjustment and manual pump operation at both locations. Controllers shall display levels of all tanks / compartments whether or not that particular tank / compartment is selected as the active tank / compartment for control of the system. House (and suction) tank screens are available at each location. Levels of all tanks or tank compartments house (and suction) tanks with level transducers shall appear, whether or not that particular tank / compartment is selected as the active tank / compartment for control of the system. The controller screen shall be graphically self scaling as the level fluctuates and when set points are changed. No tools or meters shall be required to calibrate the unit. System set points shall be maintained in non-volatile memory. These system parameters shall be intuitively modifiable through touch screen numerical keypads, no sophisticated field programming shall be required. The controller shall provide a level simulation mode, whereby a technician can test all component functions. The controller shall data log pump operation and all alarm events. Critical service alerts, field service contacts, system designation, pump serial numbers and system help screens shall be readily available through the touch screen.

The SCADA ready controller shall support the transferring of files and screens over LANs including Modbus communications with the Building Management System. It shall be configurable for network communications via optical cable, high speed Ethernet, RS-232 / 485 serial ports, USB ports, universal convertible inputs, phone lines, cellular or wireless spread spectrum radio.

Communication points shall, at a minimum, include the following:
• One (1) High speed Ethernet
• Five (5) RS-232/485 serial ports
• Four (4) USB ports
• Eight (8) Universal inputs

The controller shall be designed for serviceability
• Should the touch screen become damaged, the level control system shall continue to operate normally until the touch screen is replaced.
• Should the logic controller become inoperable the back-up float system shall activate an alarm while maintaining automatic system operation.
3. Level controls shall consist of one (1) level transducer and two (2) redundant, back-up, level sensors, for each tank / compartment.

   a. The level transducer shall be a submersible suspended type, 316 stainless steel construction, reverse polarity, and surge protected, vented to atmosphere, having a 4-20 mA output, furnished with 100' of cable with 200 lb. pull rating. The transducer shall monitor tank level and temperature. It shall be positioned 6" above the bottom of the tank by attachment to a retrievable, 5 lb., stainless steel, tip-proof, mounting fixture.

   b. Suction Tank: The two (2) back-up level sensors shall be suspended, weighted type, non-mercury, differential level sensor float switches with adjustable tether, furnished with 50' of cable. Float switches shall be positioned as follows: redundant high level back-up float (NO) above the transducer high level set point, redundant valve control / low level alarm (NC) back-up float below the transducer low water level alarm set point elevation.

   b. House Tank: The two (2) back-up level sensors shall be suspended, weighted type, non-mercury, differential level sensor float switches with adjustable tether, furnished with 50' of cable. Float switches shall be positioned as follows: redundant pump start / stop level back-up float below the transducer low water level alarm set point elevation, double redundant high level back-up float above the transducer high level set point.

   c. Wiring between the transducer, level switches, level control panel and pump controller shall be furnished and installed by the electrical contractor as follows:

      1. Field wiring from each tank compartment to level control panel shall be connected through a terminal transition junction box, furnished by the manufacturer and described below:
         • 1 - multi-conductor transducer cable
         • 4 - wires for back-up floats
         • 6 - wires for high level safety shutoff valve (position switches & solenoid operation)

      IF SUCTION TANK ONLY

      2. Additional wiring, as needed, from level control panel to:
         • 2 - wires for pump system low water cutoff

      2. Field wiring from (the) (each) upstairs level control panel to downstairs pump controller shall be furnished by the manufacture and installed by the electrical contractor in as follows:
Domestic Water Pumps

2.5 PUMP CONTROLLERS

1. Single compartment, NEMA-4 watertight / dust-tight gasketed enclosure with drip shield, hospital grade, having a field adaptable controller power feed arrangement, configured to facilitate system installation, accepting either one main power feed, or individual power feeds to each pump, to be determined in the field at the time of installation to suit field conditions.

   a. Circuit Breaker disconnect switches interlocked with compartment door, for each pump.

   b. Three pole solid state soft start, reduced voltage type motor starters with three phase thermal overload protection and low voltage release, for each pump.

   c. Three phase power monitor for each pump's power feed.
d. 115 volt main control power circuit transformer fused on both the primary and secondary sides with flip-flop, automatic transfer circuit on the primary side to insure continuous power under either power feed arrangement.

e. Control power available lights (all voltages) with auxiliary alarm contacts.

f. 115 volt individual pump control circuit transformers fused on both the primary and secondary sides, for dedicated emergency back-up operation of each pump in hand.

g. Integral UPS, uninterruptible power supply, for emergency operation of the control system in the event of power failure.

h. H-O-A selector switches with "H-O-A Off" auxiliary alarm contact.

i. Automatic "PAL" pump alternator.

j. Pump run indicating lights.

k. Alarm indicating lights.

l. Audible alarm, silencing push-button and remote trouble alarm contacts.

m. House (& suction) tank level controller with 7" bright color touch screen duplicating that provided in the in the remote level indicating controller at the house tank(s). (Note: this single controller through multiple touch screens controls all house tanks and the suction tank, no additional suction tank control shall be needed.)

n. 24 VDC power supply with circuitry for back-up floats, control power available light and auxiliary alarm contacts.

o. 24 VDC suction tank transducer.

p. Active suction tank / compartment selector switch.

q. Set of necessary control relays and other accessory devices required to permit the system to operate in conformance with the specifications.

r. Set of panel mounted pressure gauges (pump discharge, suction & riser pressure) and switches.
s. All components shall be mounted on back panels.

t. Motor starters shall be fully sized in accordance with NEMA ratings.

u. All fuses shall have a status indicating light which illuminates if a fuse is blown for quick trouble-shooting with use of a meter.

v. All internal wiring shall be numbered corresponding to the wiring diagrams.

w. All connections to auxiliary contacts and control components, whether remote or panel mounted, shall be made to terminal strips.

x. The control panel shall bear the UL508 label of Underwriters Laboratories signifying that all work performed by the manufacturer is in compliance with the requirements of the Underwriters Laboratories. Approval of just the enclosure or electrical devices is unacceptable.

2.6 SUCTION TANK LEVEL CONTROLS

1. Level controls shall consist of one (1) level transducer and two (2) redundant, back-up, level sensors, for each tank / compartment.

   a. The level transducer shall be a submersible suspended type, as described for the house tanks.

   b. The two (2) back-up level sensors shall be suspended, weighted type, non-mercury, differential level sensor float switches with adjustable tether as described for the house tanks. Float switches shall be positioned as follows: redundant high level back-up float above the transducer high level set point, redundant valve control / low level alarm back-up float below the transducer low water level alarm set point elevation.

   c. Wiring between the transducer, level switches, level control panel and pump controller shall be furnished and installed by the electrical contractor as follows:

      1. Field wiring from each tank compartment to level control panel shall be connected through a terminal transition junction box, furnished by the manufacturer as described for the house tanks.

      • 1 - multi-conductor transducer cable
      • 4 - wires for back-up floats
      • 6 - wires for high level safety shutoff valve (position switches & solenoid operation)
2.7 OPERATING SEQUENCE AND ALARMS

1. The electrical control system shall start/stop and alternate the pumps on a lead/lag basis as required by the tank level controls and activate alarms. The solid state soft start controls shall ramp up and down the pumps' speed upon starting and stopping thus preventing hydraulic shock. Upon failure of one pump or its scheduled shutdown for service, the remaining pump shall operate automatically.

Pumps shall be automatically alternated via "PAL" predictable alternation logic. "PAL" shall enable the operator to input a percentage of total run time for any pump, thereby assuring either equal or un-equal run time, if so desired, for staggered pump maintenance. "PAL" alternation shall provide smooth pump overlap transition, such that the new pump starts prior to the original pump stopping.

a. Alarms shall include: High and low tank level, low suction, pump trouble due to power problem, pump controller control power failure (no audible), UPS online, relay panel power failure, individual pump failure and Back Up Active / PC failure.

2. In the event of a high tank level condition, the pumps shall be cut-off and the high water level alarm shall be activated. Pumps and alarm shall automatically reset when conditions return to normal. Additionally, an auxiliary alarm contact shall be provide for interconnection with a high water level safety solenoid shutoff valve.

3. In the event of a low tank level condition, all pumps shall be started and the low water level alarm shall be activated. Pumps and alarm shall automatically reset when conditions return to normal.

4. In the event of a low suction condition, the pumps shall be cut-off and alarm shall be activated. Pumps and alarm shall automatically reset when conditions return to normal.

5. In the event of a pump power problem, phase loss, phase reversal, overvoltage, undervoltage, unbalanced voltages or overload trip of any pump, the pump shall be shutdown, operation will automatically transfer to the next pump and a pump trouble alarm shall be activated, manual reset required.

6. In the event of a pump failure, the pump shall be locked out, failure alarm shall be activated and the next pump in sequence shall take its place. Manual reset required.
7. All alarms shall be audio-visual, except as noted, with silencing push-button and two (2) sets of Form "C" auxiliary alarm contacts for remote trouble alarm (2-NO, 2-NC).

8. All start/stop and alarm set points shall be field adjustable. Activation of all alarm functions shall follow field adjustable time delays.

2.8. MULTI-TIERED REDUNDANT EMERGENCY OPERATION

In addition to the above "normal" control and alarm sequencing should any of the electronic controls fail to function for any reason the following levels of redundant operation will occur as needed:

1. Level One Redundancy - House Tank
   Should the level drop below the primary level system's low water level alarm set point, the low level back-up differential float switch shall start all pumps and provide for redundant activation of the low water level alarm. Should the level rise above the primary level system's high level alarm set point, the high level back-up differential float switch shall provide redundant activation of the high water level alarm and energize the solenoid pilot of the high water level safety shut off valve to close the valve and stop the tank fill pumps. The pumps will be automatically controlled by the lower back-up float. The back-up active alarm and the back-up low or high water alarms will remain active. The above will continue until corrected.

2. Level Two Redundancy - House Tank
   Should the (NC) normally closed lower float ball become water logged, the level would continue to rise until the (NC) normally closed upper back-up float switch is activated to stop the pumps. The pumps will be automatically controlled by the upper back-up float. The back-up active alarm and the back-up low or high water alarms will remain active. The above will continue until corrected.

3. Level Three Redundancy - House Tank
   Should the upper level back-up float fail to stop the pumps, the water level would continue to rise until it reaches the back-up mechanical ball float pilot of the high water level safety shut off valve shutting off the water preventing tank overflow. The mechanical float will automatically open & close to maintain level and activate an alarm.

4. Level Four Redundancy - House Tank
   Should both back-up floats both fail to control the pumps, a single operator at the pump controller will know the tank level status and be able to manual start & stop pumps, without radio communication to the tank area. By watching the riser pressure gauge on the con-
troller with one or two pumps running, the operator will see the pressure rise when the flood prevention high water level safety control valve has closed and will see it drop when the valve has opened.

5. Level One Redundancy - Suction Tank
   Should the level drop below the primary level system's low water level alarm set point, the low level back-up differential float switch shall provide redundant activation of the low water level alarm, activate the solenoid make-up valve and cutoff the pumps. When the level rises the alarm shall automatically reset. Should the level rise above the primary level system's high level alarm set point, the high level back-up differential float switch shall provide redundant activation of the high water level alarm and activate a solenoid pilot on a high water level safety shutoff valve

6. Level Two Redundancy - Suction Tank
   Should the upper level back-up float fail to stop the pumps, the water level would continue to rise until it reaches the back-up mechanical ball float pilot of the high water level safety shutoff valve shutting off the water preventing tank overflow. The mechanical float will automatically open & close to maintain level and activate an alarm.

2.9 HOUSE (AND SUCTION TANK) HIGH LEVEL SAFETY SHUTOFF AND FILL VALVE(S)

1. Provide an automatic level control valve, for (each) (the) House (and Suction) tank (/ compartment). Valves shall have a dual diaphragm, Gemini, assembly with primary and secondary pilot systems for integral redundant control. Valves shall be installed in an accessible location, inside the building, as shown on the plans, to allow for installation and servicing without the need to enter the tank.

2. The Gemini automatic control valve shall be operated by the fluid action in either of two (2) chambers having independent diaphragms and independent pilot systems capable of operating a common valve. In normal operation, the primary inner valve assembly shall be the only moving part. The secondary back-up assembly shall remain stationary, unstressed and shall not interfere with normal primary valve operation, until required. The two (2) diaphragms shall be flexible, non-wicking, FDA approved; nylon fabric reinforced synthetic elastomer, each forming a sealed chamber operating free of drag or wear. Diaphragms shall not be used as seating surfaces. The stem assembly shall be fully guided by separate upper and lower bearings to preclude binding or deflection.

DESIGNER NOTE: USE IF HOUSE TANK IS INDOORS USE FLOAT VALVE

3. HOUSE TANK FLOAT VALVE: Each valve shall be Claval: solenoid and float operated dual diaphragm type control valve, size as shown on the plans. The valve shall serve as a
means of high water level safety shutoff and redundant make-up, operating within an ad-
justable, differential, level range in an on-off, non-modulating manner. Primary control shall
be a solenoid pilot operated by an electrical signal from the tank level control system.
Secondary, back-up, control shall be a ball float.

DESIGNER NOTE: USE IF HOUSE TANK IS OUTDOORS USE ALTITUDE VALVE LOCATED INSIDE
THE BUILDING

3. HOUSE TANK ALTITUDE VALVE: Each valve shall be Claval solenoid and altitude pilot
operated dual diaphragm type control valve, size as shown on the plans. The valve shall
serve as a means of high water level safety shutoff and redundant make-up, operating with-
in an adjustable, differential, level range in an on-off, non-modulating manner. Primary
control shall be a solenoid pilot operated by an electrical signal from the tank level control
system. Secondary, back-up, control shall be an altitude pilot.

4. SUCTION TANK: Each valve shall be Claval solenoid and float operated dual diaphragm
type control valve, size as shown on the plans. The valve shall maintain tank level within
an adjustable, differential, range in an on-off, non-modulating manner. Primary control
shall be a solenoid pilot operated by an electrical signal from the tank level control
system. Secondary, back-up, control shall be a ball float.

5. Valve body shall be globe pattern constructed of ductile iron with 12 mil thick fused epoxy
coating with ANSI Class 150 flanges, 250 PSI maximum working pressure. The main
valve trim shall be of 316 stainless steel. Stem shall be Oxy-Nitride coated for increased
lubricity, resistance to mineral deposits and enhanced corrosion protection. Bonnets shall
be tapped with manual air release port to relieve entrained air when valves to be installed
in the vertical plain, up to 6” valve size.

DESIGNER NOTE: USE IF FLOAT VALVE PILOT SYSTEM

6. Primary pilot systems shall include: solenoid pilot, pilot line strainers and isolation ball
valves. Solenoid valve, NEMA 4, shall be powered at 110-120 volts from the tank level
control panel, valve is normally open (NO) requiring power to close. Secondary pilot system
shall include: Model 39 non-modulating float pilot, pilot line strainer, isolation ball valves,
stainless steel ball float with stainless steel rod. Valve shall include position switches indi-
cating primary and secondary operation, NEMA 4.

DESIGNER NOTE: USE IF ALTITUDE VALVE PILOT SYSTEM

6. Primary pilot systems shall include: solenoid pilot, pilot line strainers and isolation ball
valves. Solenoid valve, NEMA 4, shall be powered at 110-120 volts from the tank level
control panel, valve is normally open (NO) requiring power to close. Secondary pilot system
shall include: Model 301-4 altitude pilot, pilot line strainer and isolation ball valves. Valve shall include position switches indicating primary and secondary operation, NEMA 4.

7. Valves shall be designed for ease of assembly and maintenance and shall be completely serviceable in-line without need for special tools. Main valve bonnet shall have a removable cap for easy access to spring and upper bearing without having to remove the main valve bonnet or pilot system.

8. The valve shall be tested prior to shipment including a pressure test and a functional operational test. Valve shall carry a three (3) year warranty and a *Lifetime Seat Replacement Guarantee*.

9. Contractor shall furnish and install:
   - IF FLOAT VALVE: Copper tubing between float pilot and main valve, per manufacturer's schematic.
   - IF ALTITUDE VALVE: 1" Copper tubing with isolation valve between the altitude pilot and the down feed from the tank, per manufacturer's schematic.
   - Field wiring between the tank level controls, 120 volt power supply, position indicating limit switches and solenoid pilots.

2.10. SUBMITTAL DATA
The submittal data for the pumping system shall include, as a minimum: pump curves, system data sheets and drawings, complete description of control panel with wiring diagram specifically for this project, sequencing data, instrumentation and alarms.

2.11 START-UP & WARRANTY
Start-up services including pump alignment, adjustment and field calibration of controls, operator instruction and system warranty shall be included in the price for the system. The control system warranty shall be 12 months from date of startup not to exceed 18 months from time of shipment.

2.12 DOMESTIC WATER BOOSTER PUMP

A. Manufacturers:
   1. American Marsch-Neptune Series
2. Bell & Gossett Domestic Pump; ITT Industries.
3. Federal Pump

B. Furnish and install a packaged (triplex), variable speed water pressure booster system as Neptune Series as manufactured by American Marsch the packaged and tested system shall provide the max capacity of ___gpm system flow at a system pressure of ____ psig including a minimum suction pressure of 30 psig. The only connections required shall be inlet and outlet piping; and connection of the electrical service to control panel. The system shall consist of 2 operating pumps, and a third standby.

The pumps shall be vertical multistage, centrifugal type series equipped with a mechanical seal. Each pump shall include a bronze modulating thermal safety valve to prevent overheating of the pump casing. Each pump shall provide ___ gpm @ ___ foot' boost. Motors shall be hp __ rpm, 460 voltage, 3 phase, 60 hz tefc premium efficiency. To protect the pump against overheating, provide a mechanical over-temperature protection device on the pump discharge that will divert flow to drain when water temperature exceeds 140° F.

C. Each pump shall include a two piece bronze 600psi WOG non shock ball valve isolation valves on the inlet and outlet of each pump to provide service of the pump. A bronze silent check valve shall also be incorporated between the pump and ball valve on the discharge.

D. The system discharge pressure shall be controlled by varying the speed of the pumps/s to increase or decrease the pressure of the system at the discharge header. The booster controls shall use a single source of power provided to a through the panel disconnect housed in a NEMA 1 enclosure. An individual circuit breaker shall be provided for each Variable frequency Drive (VFD). A terminal block for connecting remote alarms shall be provided in the disconnect panel. Individual VFD’s for each pump shall be mounted, wired, and networked together providing normal PID control, pump alternation, Lead/Lag control, low suction alarm, high pressure alarm, and pump sleep control. Two pressure transducers shall be wired in for automatic redundancy. The VFD’s shall include:

- Programmable set point and scaling
- Adjustable lead/lag pump sequencing
- Electronic pump alternation
- Sleep mode minimum flow protection
- Pump running pilot lights
- HOA selector switches
- Adjustable minimum run period timers
• Automatic system restart  
• Friction loss compensation  
• Lead pump failure protection  
• Pressure sensors for each drive to provide redundancy  
• Low suction alarm with booster shut down and auto reset  
• High and low pressure feedback detection  
• Motor protection by monitoring output phase loss, ground fault, motor overload, motor over temperature.  
• Pump fault and alarms for over cycling, no flow, loss of prime, transducer loss, over torque.  
• Terminal block with contacts for remote alarm

E. Provide Variable Frequency Controllers designed for use with AC induction pump motors incorporating true pump control system logic, and pump terminology embedded within the controller and displayed on the programming operator interface. The controllers shall have a complete integrated pumping macro with its pump specific parameters allowing the operator to setup specific control values for a wide range of pumping applications such as constant pressure, constant flow, and level control. The controller will automatically adjust pump operating conditions, as the process variables change within the defined programmable pump settings while still maintaining optimum pump performance and protection.

F. Standard Variable Frequency Drives (VFD’s) NOT incorporating true pump control terminology, pump curve NO Flow & Dead Head detection settings, System Pre-Charge Levels, Independent Thrust Bearing Control, Multiplex Operation, and Multiple pump alarm messages specific to the pump control system and motor shall not be considered equal or acceptable.

G. Provide a factory pre-charged, ASME code and NB stamped, HydroCumulator tank. Include a replaceable FDA approved Butyl rubber flexible membrane to separate air and water. No water shall come in contact with the walls of the tank. The HydroCumulator tank shall be shipped pre-charged to the proper design conditions. Provide pressure switch and flow sensor to automatically control lead pump operation. These controls shall prevent lead pump short-cycling while maximizing the stored water available from the HydroCumulator tank. The tank shall be located adjacent (off the skid) to the pumping package, as indicated on the plans. Contractor shall install the tank and provide floor drain as required by the manufacturer for adequate serviceability.
H. The packaged pumping system shall be factory assembled and tested with ( ) type "L" copper piping and shall include pressure gauges for each header. It shall be cleaned and painted with a high grade enamel prior to shipment. The service of a factory trained representative shall be made available on the project site for start-up and instructing operating personnel.

I. The factory authorized local representative shall provide up to 4 hours of startup and field training.

J. Each AMP Booster System shall be warranted for a period of (18) months from date of shipment or (12) months from date of startup, which ever occurs first and in accordance with AMP’s standard manufacturer’s warranty

K. FIELD PIPING

The contractor shall pipe the temperature relief valve discharge line to the drain. To reduce the possibility of damaging vibration, the contractor shall install the pump system on a flat housekeeping pad, bolted and grouted in place. The pump system shall be piped with a bypass and isolation valves, and with flexible connectors at the header connections.

END OF SECTION 221123
SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.2 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency. Each pipe and fittings shall be marked with the following:

1. Manufacturer’s name or registered trademark.
2. Country of Origin
3. Date of Manufacturer (pipe only)

1.3 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.
2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.


   a. Manufacturers:

      1) ANACO.-Husky 4000
      2) Clamp-All Corp.-Hi Torq 125

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.

C. Pressure Fittings:


D. Grooved-Joint Systems:

   1. Manufacturers:

      a. Anvil International.
      b. Star Pipe Products; Star Fittings Div.
      c. Victaulic Company.
      d. Ward Manufacturing, Inc.
2. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.

3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.4 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

   a. Fernco, Inc.
   b. Mission Rubber Co.

2. Sleeve Materials:

   b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

   1. Manufacturers:

      b. EBAA Iron Sales, Inc.
      c. Romac Industries, Inc.

   2. Center-Sleeve Material: Ductile iron.
   3. Gasket Material: Natural or synthetic rubber.
   4. Metal Component Finish: Corrosion-resistant coating or material.

C. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

   1. Manufacturers:

      a. EBAA Iron Sales, Inc.
2.5 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping shall be the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, vent piping smaller shall be the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Underground, soil, waste, and vent piping shall be the following:
   1. Extra-Heavy Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be the following:
   1. Hard copper tube, Type L copper pressure fittings; and soldered joints.
   2. Steel pipe, pressure fittings, and threaded joints.

F. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
   1. Hard copper tube, Type L copper pressure fittings; and soldered joints.
   2. Steel pipe, pressure fittings, and threaded joints.
   3. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.

G. Underground sanitary-sewage force mains shall be any of the following:
1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.
   a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

2. Push-on-joint, ductile-iron pipe; push-on-joint ductile-iron fittings; gaskets; and gasketed joints.
   a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

3. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

END OF SECTION 221316
SANITARY WASTE PIPING SPECIALTIES
SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Trench drains.
5. Channel drainage systems.
6. Roof flashing assemblies.
7. Through-penetration firestop assemblies.
10. FOG disposal systems.
13. Oil interceptors.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and grease removal devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

c. Tyler Pipe; Wade Div.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Size: Same as connected piping.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
B. Drain-Outlet Backwater Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div
      c. Tyler Pipe; Wade Div
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Size: Same as floor drain outlet.
   3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
   4. Check Valve: Removable ball float.
   5. Inlet: Threaded.
   6. Outlet: Threaded or spigot.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
      e. Josam Company; Blucher-Josam Div.
   2. Standard: ASME A112.36.2M for cast iron ASME A112.3.1 for stainless steel for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee or Stainless-steel tee with side cleanout as required to match connected piping.
   5. Closure: Countersunk, brass cast-iron plastic plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
c. Tyler Pipe; Wade Div.
d. Zurn Plumbing Products Group; Specification Drainage Operation.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

Josam Company; Blucher-Josam Div.

2. Standard: ASME A112.36.2M for adjustable housing heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: As required.
7. Outlet Connection: Inside calk, Spigot or Threaded.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with threads or set-screws or other device.
11. Frame and Cover Shape: Round Square.
12. Top Loading Classification: Extra Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
15. Size: Same as connected branch.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Tyler Pipe; Wade Div.
   d. 
   e. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass/cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.

   2. Drains shall be as scheduled on the plans.

B. Stainless-Steel Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Blucher-Josam Div.
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.

   2. Drains shall be as scheduled on the plans.
   3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Oatey.
      c. Sioux Chief Manufacturing Company, Inc.
      d. Zurn Plumbing Products Group; Light Commercial Operation.

   4. Drains shall be as scheduled on the plans.
2.4 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Drains shall be as scheduled on the plans.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   a. NPS 2: 4-inch minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch minimum water seal.

C. Floor-Drain, Trap-Seat Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:
   1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend [1 inch] [2 inches] <Insert dimension> above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
   2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:
   1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
   2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:
   1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
   2. Size: Same as connected stack vent or vent stack.
H. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.


E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.8 FOG DISPOSAL SYSTEMS

A. FOG Disposal Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Standard: IAPMO PS 118, for removing solids from and breaking down and digesting suspended fats, oils, and greases from food-preparation or -processing wastewater.

3. Flow-Control Fitting: Matching unit size.

4. Strainer Unit: Stainless-steel housing with aluminum cover and removable-basket-type, stainless-steel, wire-mesh strainer. Include pressure plug instead of cover.

5. Media Chamber: Stainless-steel housing and aluminum cover, with internal baffles, piping, plastic coalescing surfaces, and clarifier section with test ports. Include stainless-steel extension.

6. Shelf: Stainless steel, 19.5 inches wide by 13 inches high by 8.75 inches deep, for metering pump, control devices, and culture bottle.

7. Culture Metering Pump, Timer, Control, and Tubing: Proprietary.

8. Culture: Include 1-gal. bottle, as recommended by unit manufacturer.

9. Strainer and Media-Chamber, Unit Size: 20 gpm or 35 gpm.

10. Inlet and Outlet: NPS 2.

11. Strainer and Media-Chamber, Unit Size: 50 gpm or 75 gpm.

12. Inlet and Outlet: NPS 3.

13. Piping: Waste and vent piping is specified in Division 22 Section "Sanitary Waste and Vent Piping."

14. Power Requirement: 120-V ac or as required.


2.9 GREASE INTERCEPTORS

A. Grease Interceptors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Rockford Sanitary Systems, Inc.
   d. Tyler Pipe; Wade Div.
   e. Zum Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation or -processing wastewater.
3. Plumbing and Drainage Institute Seal: Required.
4. Body Material: Cast iron or steel.
5. Interior Lining: Corrosion-resistant enamel.
7. Body Dimensions:
8. Body Extension:
9. Flow Rate:
10. Grease Retention Capacity:
11. Inlet and Outlet Size:
12. End Connections: Flanged, Hub or Threaded.
15. Flow-Control Fitting: Required.
16. Operation: As required.

2.10 GREASE REMOVAL DEVICES

A. Grease Removal Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Blucher-Josam Div.
   b. Lowe Engineering; a division of Highland Tank & Manufacturing Co., Inc.
   c. Thermaco, Inc.

4. Interior Separation Device: Baffles and/or Screens.
5. Heater: As required.
6. Interior Lining: Not required
7. Exterior Coating: Not required.
8. Unit Dimensions:
9. Flow Rate:
11. Inlet and Outlet Size:
12. End Connections: Flanged, Hub or Threaded.
15. Flow-Control Fitting: Required.
17. Power Requirement: 120-V ac (Coordinate w/Electrical Engineer).

2.11 OIL INTERCEPTORS

A. Oil Interceptors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Rockford Sanitary Systems, Inc.
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Type: Factory-fabricated interceptor for separating and removing light oil from wastewater.
3. Body Material: Cast iron or steel.
4. Interior Lining: Corrosion-resistant enamel.
5. Exterior Coating: Corrosion-resistant enamel.
6. Body Dimensions:
7. Flow Rate:
8. Inlet and Outlet Size:
12. Flow-Control Fitting: Required.
13. Descriptive Type or Function:
14. Oil Storage Tank:

2.12 SOLIDS INTERCEPTORS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Rockford Sanitary Systems, Inc.
c. Tyler Pipe; Wade Div.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Type: Factory-fabricated interceptor made for removing and retaining lint or sediment from wastewater.

3. Body Material: Cast iron or steel.

4. Interior Separation Device: Baffles or Screens.

5. Interior Lining: Corrosion-resistant enamel.


8. Inlet and Outlet Size:


10. Mounting: [Above floor] [Inline] <Insert mounting>.

END OF SECTION 221319
SANITARY SEWERAGE-SUMP PUMPS
SECTION 221329 - SANITARY SEWERAGE-SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sewage pumps and accessories for sanitary drainage piping systems in buildings:
   1. Submersible sewage pumps.
   2. Sewage pump basins.
   3. Packaged, submersible sewage pump units.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.01 DUPLEX (SEWAGE EJECTORS) (SUMP PUMPS)

A. Provide a duplex (sewage ejector) (sump pump) system in a concrete pit. OR Fiberglass basin. The system shall include two (2) Model: (____" CP______, impeller no. ____), totally submersible heavy duty pumps) *OR* (____" NP______, impeller no. capable of handling solids, fibrous materials, heavy sludge and other matter found in unscreened wastewater and designed to pump air and liquid in combination without becoming airbound. Each pump shall be equipped with cast iron discharge connection. Pumps shall be rated for ____ GPM at ____' TDH, (minimum shutoff head at no flow shall be ____) with ____ HP, ____ RPM, ____ volt, 3 phase, 60 Hz totally submersible motors.

B. Approved Manufacturers: Subject to compliance with all specified requirements, provide products as produced by the manufacture used as the basis of design. Other manufacturers, whose products have been in satisfactory use in similar service for not less than 10 years, may
be submitted for approval as an equal provided the submission contains sufficient information for evaluation and the manufacturer certifies compliance with the performance, physical characteristic requirements and operational features of these Specifications.

1. Gorman Rupp
2. Goulds pumps
3. Yeomans Chicago Corporation
4. Federal Pumps
5. Zoeller Company
6. American Marsh

C. Guide rail removal system shall eliminate the need for personnel to enter the pump well to remove bolts, nuts or other fastenings. Pumps shall be automatically connected to the discharge piping by a single linear downward motion of the pump, pressing tightly against the discharge connection for a machined metal-to-metal tight seal without need for any gaskets. The entire weight of the pump shall be guided into place with non-load-supporting guide rails with no weight of the pump bearing directly on the pit floor.

D. Motors shall have a dry air filled shell with Class H insulation, designed for 180 °C maximum and voltage tolerance shall be +10% and -14%. The motor shall be capable of 30 equal starts per hour and shall be non-overloading of the complete pump curve. Pump and motor shall be capable of running continuously in a totally dry condition. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be insulated by the trick-le impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing, secured without the use of bolts, pins or other fastening devices that require penetration of the stator housing. Motors shall have, protective thermal switches embedded in the windings of each phase and wired to the control panel. The junction chamber with terminal board shall have a watertight sealing gland between chamber and motor housing. Motor/pump shaft shall be the same continuous unit, with no coupling required, constructed of ASTM A479 S43100-T stainless steel. It shall rotate on two permanently grease lubricated bearings. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. The motor cable shall be non-wicking with strain relief at the junction chamber, strain relief and water sealing shall function separately. Cable sealing shall be accomplished by means of an elastomer grommet compression fitting, facilitating field cable service without the need for Epoxies, silicones, or other secondary sealants. The motor and pump shall be designed and produced by the same manufacturer.

E. Mechanical seal systems shall consist of two (2) totally independent seal assemblies operating in a lubricant chamber. The tandem seals shall have two separate tungsten-carbide lapped
face rings, no common parts shall be shared between the seals. The lower compression spring shall be protected against exposure to the pumped liquid. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The mechanical seals and pump shall be designed and produced by the same manufacturer.

F. Major pump components, stator casing, oil chamber, volute and impeller, shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

G. Controller: NEMA-250, Type 4, watertight / dust-tight gasketed enclosure with drip shield, hospital grade, for 3 phase, 60 HZ, 3 wire power supply, including:

1. Circuit Breaker disconnect switches interlocked with compartment door
2. Three pole across-the-line motor starters with three phase thermal overload protection and external reset buttons
3. Three phase power monitor for each pump's power feed.
4. 115 volt and 24 volt control power circuit transformers fused on both the primary and secondary sides with individual power available lights and auxiliary alarm contacts.
5. Control power available lights (all voltages) with auxiliary alarm contacts.
6. 115 volt individual pump control circuit transformers fused on both the primary and secondary sides, for dedicated emergency back-up operation of each pump in hand.
7. Integral UPS, uninterruptible power supply, for emergency operation of the control system in the event of power failure.
8. Logic control module and HMI color touch screen.
10. Motor insulation fault monitor.
11. GAF Flush-Cleanse circuit.
12. Redundant level control circuit

13. High Temperature Quench Circuit.


15. Set of necessary control relays and other accessory devices required to permit the system to operate in conformance with the specifications.

16. All components shall be mounted on back panels.

17. All power supplies shall have loss of power alarm contacts.

18. All fuses shall have a status indicating light which illuminates if a fuse is blown for quick trouble-shooting with use of a meter.

19. All internal wiring shall be numbered corresponding to the wiring diagrams.

20. All connections to auxiliary contacts and control components, whether remote or panel mounted, shall be made to terminal strips.

21. The control panel shall bear the UL508 label of Underwriters Laboratories signifying that all work performed by the manufacturer is in compliance with the requirements of the Underwriters Laboratories. Approval of just the enclosure or electrical devices is unacceptable.

22. The controller shall be configured to accept both power feed arrangements: one main power feed, or individual power feeds to each pump, to be determined in the field at the time of installation. The transformer shall have a, flip-flop, automatic transfer circuit on the primary side to insure continuous power under either arrangement.

23. The controller shall include auxiliary contacts (Form "C" (1-NO, 1-NC)) and analog output signal for interface with building automation system, for the following:
   a. Control power available.
   b. On-off status of each pump.
   c. Common system trouble alarm status.
   d. Wet well level indication, 4-20 mA output signal.

24. Control panels which rely upon a programmable logic controller ("PLC") or employ electronic level sensors shall have redundant electromechanical devices which function to maintain automatic pump operation and alarm activation in the event of control failure.
H. Logic control module shall be a SCADA ready, intelligent, modular unit, capable of data acquisition, processing, logging, alarm management and communications. The interactive HMI color touch screen shall have a bright high resolution 7” display not less than 800 x 480 pixels. The device shall have multiple screens and multiple operator security password levels. The primary screen shall provide for a minimum of twenty-six (26) visual and touch status points.

1. It shall Graphically represent the real time status and provide set point adjustments of the following system components:
   a. wet well water level
   b. pump activation levels
   c. pump run
   d. pump run elapsed time log
   e. wet well water temperature
   f. wet well quench system
   g. Flush-cleanse system
   h. high water level alarm
   i. low water level alarm
   j. high water temperature alarm
   k. back-up float
   l. time & date

2. Logic control module shall be designed for serviceability. Should the touch screen become damaged, the level control system shall continue to operate normally until the touch screen is replaced.

I. Sequence of operation shall be as follows: Upon increasing liquid level the lead pump sensor shall activate, lead pump shall start and pump down to the pump off level set point. If the level continues to rise to the lag pump level set point, lag pump shall start and pump together with the lead pump down to the pump off level set point.

1. The high water level alarm set point shall activate the alarm system should the level continue to rise.

2. In the event of a pump power problem, phase loss, phase reversal, overvoltage, undervoltage, unbalanced voltages or overload trip of any pump, the pump shall be shut-down, operation will automatically transfer to the next pump and a pump trouble alarm shall be activated, manual reset required.

3. In the event of any failure of the primary level control system, a redundant level system shall operate the pumps automatically and activate the alarm indicating light and auxiliary alarm contact (no audible). The redundant system shall also provide for automatic system operation in the event that the logic controller is removed for service.
4. In the event of control power failure in either the primary or redundant circuits, auxiliary alarm contacts shall be activated.

5. Pumps shall be automatically alternated via "PAL" predictable alternation logic. "PAL" shall enable the operator to input a percentage of total run time for any pump, thereby assuring either equal or un-equal run time, if so desired, for staggered pump maintenance.

6. The controller shall monitor the integrity of motor insulation prior to every start and alarm if problem exists.

7. The control panel shall include a GAF Flush-Cleanse Controller to purge the pit of sediment, floating solids and grease. Twice per day the controller shall energize the Flush system and lower the liquid level of the pit below the pump stop float to a pump snore condition. The interval between Flush-Cleanse cycles and the duration of the cycle may be operator selected. During the cycle, the low water level alarm system shall be deactivated.

J. Level sensors: Submersible level transducer, suspended type, 316 stainless steel construction, reverse polarity, and surge protected, vented to atmosphere, having a 4-20 mA output. The transducer shall monitor wet well level and temperature. It shall be installed and held in position by means of a guide pipe retrieval mounting fixture. One differential level sensor shall be installed as a redundant level control device.

K. Provide an FPS-DJB, NEMA 4X, stainless steel, double junction box, environmentally sealed to prevent the intrusion of corrosive sewer gases and humidity to the electrical connections and the pump control panel while facilitating installation and the removal of pumps for inspection & service. Each box shall be a minimum of 10" x 12" x 5" deep. The lower box shall have two (2) 2" conduit bottom connections for ease of pulling the pump and level control cables from the wet well. The upper and lower boxes shall be rigidly assembled with multiple individual, sealed, strain relief gland seals for pump power and level control cables; the quantity of these connections shall be suited for the equipment provided on this project. Electrical connections from the wet well and controller shall be made at the terminal strip in the upper box. Cable gland seal plugs, permanently attached in the upper box, shall maintain the integrity of the environmental seal when cables are removed for pump inspection or service.

L. FOR STANDARD INSTALLATION IN CONCRETE PIT.

Furnish and install a ____" x ____" FPS cover, odor tight, gasketed with aluminum frame suitable for pedestrian loading. Contractor shall field measure the pit opens and coordinate frame and cover size with the supplier prior to manufacture. Frame and cover shall be two piece removable construction to facilitate installation and future replacement. The cover shall be polished aluminum, diamond plate with a hinged access hatch for pump removal. The hatch shall
have a removable T handle, stainless gas springs for easy opening and adjustable slam latch for a tight seal. Cover shall be flush with the finished floor including the latch release and hinges. Piping penetrations shall be by means of factory installed, heavy rubber, environ seals. Cover appurtenances: guide rail brackets, lifting chain, level sensor cable and pump cable holders shall be factory installed. Cover hinges and all fasteners shall be aluminum or stainless steel. The frame shall be set into the concrete floor mounted above the pumps. Contractor shall construct the perimeter edges of the pit with 3-1/2" deep x 3-1/2" wide step (standard 4x4 lumber to insure flush installation of the cover.

M. FOR INSTALLATION IN FIBERGLASS BASIN

1 Furnish and install _____" diameter x _____" deep Fiberglass basin with inlet hub as shown on the plans. Basin shall be self-supporting, constructed for Basin cover shall be an FPS odor tight, gasketed, suitable for pedestrian loading. The cover shall be polished aluminum, diamond plate with a hinged access hatch for pump removal. The hatch shall have a removable T handle, stainless gas springs for easy opening and adjustable slam latch for a tight seal. Piping penetrations shall be by means of factory installed, heavy rubber, environ seals. Cover appurtenances: guide rail brackets; lifting chain, level sensor cable and pump cable holders shall be factory installed. Cover hinges and all fasteners shall be aluminum or stainless steel.

N. The submittal data for the pumping system shall include, as a minimum: pump curves, system data sheets and drawings, complete description of control panel with wiring diagram specifically for this project, sequencing data, instrumentation and alarms.

O. Alternate manufacturers of equipment will be considered only if the contractor submits detailed information and price reductions at the time of bid opening. These detailed proposals must include sufficient catalog information, including efficiencies, dimensions, and major component identification for proper evaluation of the alternate proposed. No alternate system by another manufacturer will be considered prior to considering alternate equipment of the specified manufacturer.

P. Prior to shipment the pump manufacturer shall perform quality assurance tests to include: checks for compliance with specifications, operating the pumps submerged in water and verification of the integrity of the motor and cable insulation.

Q. The Pump Manufacturer’s Representative shall have single source responsibility for the pumps and complete control system. Start-up services including adjustment and field calibration of controls, operator instruction and system warranty shall be included in the price for the system. The pump manufacturer shall warrant the pumps being supplied for a period of five (5) years from date of shipment under normal operation and service. The warranty shall include parts and labor. The pump manufacturer shall warrant the motors for twenty (20) years from date of shipment.
R.

END OF SECTION 221329
FACILITY STORM DRAINAGE PIPING
SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.
   3. Encasement for underground metal piping.

1.2 PERFORMANCE REQUIREMENTS
A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.
   2. Storm Drainage, Force-Main Piping: 50 psig

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.3 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.


1.4 FIELD QUALITY CONTROL
A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

   a. Manufacturers:

      1) ANACO.
      2) Fernco, Inc.
      3) Mission Rubber Co.
      4) Tyler Pipe; Soil Pipe Div.


   a. Manufacturers:

      1) ANACO.
      2) Clamp-All Corp.
      3) Mission Rubber Co.
      4) Tyler Pipe; Soil Pipe Div.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12[, galvanized], threaded, cast-iron drainage pattern.

C. Grooved Joint Systems:

   1. Manufacturers:

      a. Anvil International.
      b. Victaulic Co. of America.
c. Ward Manufacturing, Inc.


3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Grooved-Joint Systems:

1. Manufacturers:

   a. Victaulic Co. of America.


3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

END OF SECTION 221413
SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
   3. Size: Same as connected piping.
   5. Cover: Cast iron with bolted access check valve.
   7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
   8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron, ASME A112.3.1 for stainless steel for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, Raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Tyler Pipe; Wade Div.
   c. Zurn Plumbing Products Group; Specification Drainage Operation.
   e. Josam Company; Blucher-Josam Div.
2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
3. Size: Same as connected branch.
4. Body or Ferrule: Cast iron
5. Clamping Device: As Required.
6. Outlet Connection: Threaded.
7. Closure: Brass plug with straight threads and gasket
8. Adjustable Housing Material: Cast iron with threads
10. Frame and Cover Shape: Round or Square.
11. Top Loading Classification: Extra Heavy- or Heavy Duty.
12. Riser: ASTM A 74, [Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Size: Same as connected branch.
15. Housing: Stainless steel.
17. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Hubless, cast-iron soil pipe test tee
5. Option for drilled-and-threaded plug in first subparagraph below is for a screw for a wall cover plate.
6. Closure: Countersunk or raised-head Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Wall Access: Round, [nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.}

2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies :
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected pipe.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Special Coating: Corrosion resistant on interior of fittings.

2.4 ROOF DRAINS

A. Metal Roof
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. .

Storm Drainage Piping Specialties
2. Standard: ASME A112.21.2M.
3. Pattern: [Balcony] [Canopy] [Cornice] [Promenade-deck] [Roof] [Scupper] pattern drain.
4. Body Material: Cast iron
5. Combination Flashing Ring and Gravel Stop: [Not required] [Required] Flow-Control Weirs: [Not required] [Required].
6. Outlet: [Bottom] [Side].
7. Dome Material: Cast iron
8. Extension Collars: [Not required] [Required].
9. Underdeck Clamp: [Not required] [Required].
10. Sump Receiver: [Not required] [Required].

2.5 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

2.6 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.


D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

END OF SECTION 221423
DOMESTIC WATER HEAT EXCHANGERS
SECTION 223500 - DOMESTIC WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 GENERAL RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
   C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   D. Comply with NSF 5 Water heaters, hot water supply boilers, and heat recovery equipment.
   E. Manufacturing firms regularly engaged in manufacture of this material meeting all capacities and operating characteristics of the specified manufacturer's product whose products have been in satisfactory use, in similar service, for not less than ten (10) years.

1.3 WARRANTY
   A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.
      1. Heat Exchanger - coils and risers, Non-Prorated 10 year guarantee against failure due to thermal shock, mechanical failure, manufacturing or material defect or erosion.
      2. Pressure Vessel - shell, liner and heads, Non-Prorated 20 year guarantee against leakage due to internal corrosion.
3. Other component parts - Shall carry a guarantee against failure due to manufacturing or material defect within one year from the date of initial operation or 18 months from date of delivery, whichever occurs first.

PART 2 - PRODUCTS

2.1 SEMI-INSTANTANEOUS STEAM to WATER HEAT EXCHANGERS

A. MANUFACTURERS

Subject to compliance with all specified requirements, provide products as produced by the manufacture used as the basis of design. Other manufacturers, whose products have been in satisfactory use in similar service for not less than 10 years, may be submitted for approval as an equal provided the submission contains sufficient information for evaluation and the manufacturer certifies full compliance with the performance, physical characteristic requirements and all operational features of these Specifications.

a. AERCO International, Inc.
b. PVI
c. Patterson Kelley
d. Reco

2.2 SHELL-AND-TUBE, DOMESTIC-WATER HEAT EXCHANGERS - STEAM TO WATER - FACTORY PACKAGED SKIDDED SYSTEM

A. Shell-and-Tube, Heating-Fluid-in-Coil, Non-circulating, Semi-Instantaneous, Domestic-Water Heat Exchangers, Steam To Water Type:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings by
a. AERCO International, Inc.

2. Description: (Simplex) (Duplex) (Triplex) Factory Packaged assembly of pressure vessel, heat-exchanger coils, controls, and specialties for heating domestic water with steam in coils.
   a. Vertical cross-flow, 2-pass, semi-instantaneous design with service water in the shell and steam in the coils. The ratio of hot water volume to steam volume shall
be a minimum of 7:1. Steam shall travel a minimum distance of 45 feet through the heat exchanger, from point of entrance to point of exit to ensure condensate sub-cooling. An integral PREHEATER, SUB-COOLING “WIZARD” COIL, shall be incorporated into the last pass of the heat exchanger further increases the thermal efficiency of the heater.

3. Construction: ASME-code, copper-lined, carbon-steel shell with minimum working-pressure rating, shown on Schedule.
   a. Shell: Carbon steel with copper lining.
   b. Heads: Bronze.
   c. Tappings: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
   d. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell except for heads, connections and controls with resilient insulation, minimum 1-1/2" thick having a "K" value of 0.25 BTU-in/hr·ft·°F.

4. Heat-Exchanger Coils: Copper 0.049" wall thickness, helically wound coils for heating fluid, capable of withstanding up to 30" WC internal vacuum. No water baffles or other supports shall be in contact with the coils. Coils shall provide automatic descaling due to expansion and contraction under varying primary fluid flow. Include pressure rating equal to or greater than heating-fluid supply pressure.

5. Steam and Condensate Risers: Schedule 80 red brass

6. Temperature Control: Adjustable, feed forward-feedback system, capable of maintaining outlet-water temperature within +/- 2 °F maximum temperature fluctuation from temperature setpoint at 0% to 100% load at a constant load and +/- 4 °F under normal diversified domestic load conditions. Circulating pumps, mixing valves and/or excessive water storage shall not be required for precise temperature control in domestic water applications. The system shall consist of:
   a. Control panel with PID temperature controller, digital display, over-temperature limit switch, flow meter for feed-forward sensing and feedback sensor.
   b. The PID temperature controller
      1) Setpoint range between 50 °F to 205 °F, password protected
      2) The following information shall be accessible locally at the controller or remotely via the communications port:
         a) Setpoint – can be changed remotely
         b) Domestic Water Outlet Temperature
         c) Over Temperature Alarm
d) Over Temperature Alarm including Auxiliary Alarm Contacts (1 NO, 1 NC)

e) Control Output Signal to valve

f) Water Flow through the heater

3) Communications: RS-232 port or RS-485 port & utilizes the MODBUS protocol for interoperability with building automation systems (confirm required port type when ordering).

c) Double safety limit switch to close the control valve and open a shell dump solenoid valve. The functions as a secondary water relief valve in an over-temperature condition.

d) Electronic steam control valve manufactured by water heater manufacturer. Valve shall be of the balanced, pilot-operated type, having a soft seat for ANSI Class VI bubble tight shut-off and equal percentage flow characteristics. Capable of operating with steam pressure up to 150 PSIG without the need for extraneous PRV's. The valve shall have the following performance characteristics:

1) 50 to 1 Turndown.

2) Electronic Actuator with Valve Fail Closed Design on loss of power

3) Time to Full Open Position: 7 seconds on 1” to 2”; 9 seconds on 2 ½” to 4”

4) Time to Full Closed Position: 7 seconds on 1” to 2”; 9 seconds on 2 ½” to 4”, including failsafe mode.

e) Power supply: 120 volt, 60 HZ and 220 volt, 50 HZ, 20 amp circuit required.

7. Components for Heating Hot-Water Unit:

a) Resilient insulation, minimum 1-1/2” thick having a "K" value of 0.25 BTU-in/hr-ft²-°F, meeting or exceeding ANSI/ASHRAE/IES Standard 90.1-1989.

b) Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves conforming to ANSI Z21.22, or pressure only if greater than 150 PSIG. Include one or more relief valves with total relieving capacity at least as great as heat input.

c) Inlet steam-side compound vacuum/pressure gauge

d) Condensate outlet orifice and swing check valve, 1”.

e) Bronze ball type shell drain valve, 2”.

f) Steam control valve described above, shipped loose for field installation.

g) Steam strainer, 80 mesh, shipped loose for field installation.

8. Factory Skidded System
a. The system shall be a factory package on a common skid base constructed of 1/2" thick 4" x 4" angled aluminum with polished aluminum diamond plate decking. The system shall be constructed so that it may be broken down by the contractor (including piping and bolted together skid sections, max 40" x 48") for ease of disassembly and reassembly as required to facilitate transport, rigging and installation.

b. Each heater shall have isolation valves for hot and cold water, steam and condensate. Valves shall be arranged so that a heater may be taken out of service while the balance of the system remains available.

c. Valves shall be full port ball type. Water valves shall have 316 stainless steel flanged bodies and solid 316 Teflon fused balls. The steam and condensate valves valve shall have cast iron flanged bodies and solid cast iron Teflon fused balls, the bodies and balls having the same expansion / contraction rate to assure Class 6 positive shutoff.

d. Piping materials for cold and hot water shall be Type L copper with silver soldered joints and dielectric fitting where required. Piping materials for steam and condensate shall be black iron.

e. Heater steam supply piping shall include: an 80 mesh Y strainer with full port brass ball valve for blowdown, condensate traps and dirt leg. Condensate shall be piped for gravity discharge.

f. Cold and hot water piping shall be piped in a reverse return arrangement to equalize flow through multiple heaters.

g. The system components and piping shall be properly supported and designed with ample space to facilitate service from one side of the skid. Pipe racks shall be integral with the package skid. The package shall be a custom fabrication designed to suit job specific requirements including piping arrangement and location of heater(s). The package shall be constructed for 150 PSIG working pressure.

h. Single point piping connections shall be required for cold water inlet, hot water outlet, hot water return, condensate, steam and electrical power supply.

i. The entire package shall be piped, wired and tested prior to shipment.
9. Unit Responsibility: The water heater Manufacturer’s Representative shall have single source responsibility for the complete water heating packaged system.

8. Service Contract: The manufacturer’s representative shall include a one (1) year service contract. The service contract period shall commence upon owner acceptance of the system. The service contract shall include a complete system inspection twice a year including: visual inspection of the heaters for damage, corrosion, leaks; record all temperature and pressure readings; blow down strainers; check heater coils for leaks; check / adjust temperature controls; verify operation of over temperature limit system; drain and blow down heaters to reduce scale build up. Any required service work to be noted in a formal inspection report along with a detailed proposal for the repairs.

10. Capacity and Characteristics: (Refer to Schedule.)

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heat exchangers specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Prepare test and inspection reports.

2.4 FIELD QUALITY CONTROL

A. Perform start-up tests and inspections.

B. Prior to start-up the contractor shall perform the following:
   1. Complete installation and startup checks according to manufacturer’s written instructions.
   2. Prior to filling the heaters, pipe the discharges from the high temperature safety solenoid and the relief valves, individually, to a clean floor drain capable of handling full flow.
   3. After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   4. Flush all piping
   5. Clean strainers
C. Manufacturer’s Field Start-Up Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic-water heat exchangers will be considered defective if proper operation cannot be demonstrated.

E. Prepare test and inspection reports.

2.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain domestic-water heat exchangers.

END OF SECTION 223500
PLUMBING FIXTURES
SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and Division 01 Specification Sections, apply to this Section.

B. New York Presbyterian Hospital Plumbing Fixtures Design Standards

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets .
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   7. Urinals.
   8. Lavatories.
   9. Showers Valves
   11. Service basins.

1.3 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim,
   fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials
   and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation,
   and maintenance manuals.
New York Presbyterian Hospital  
Engineering Design Standards  
March, 2015

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: NYC Local Law 57 of 2010 effective July 1, 2012 for maximum flow rates and consumption for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components–Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
3. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
6. Vitreous-China Fixtures: ASME A112.19.2M.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
5. Hose-Connection Vacuum Breakers: ASSE 1011.

H. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

2. Brass and Copper Supplies: ASME A112.18.1.
J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   2. Off-Floor Fixture Supports: ASME A112.6.1M.

1.5 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

1.6 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
PART 2 - PRODUCTS

2.1 FIXTURES, FAUCETS, FLUSHOMETERS AND TRIM

A. Refer to New York Presbyterian Hospital Plumbing Fixture Design Standards

2.2 MANUFACTURERS

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following: Refer to the New York Presbyterian Hospital Design Standards for location of manual and electronic faucets and flush valve.

   a. American Standard
   b. Chicago Faucets
   c. Elkay Manufacturing Co.
   d. Karran
   e. Kohler Co.
   f. T & S Brass and Bronze Works, Inc.
   g. Just Manufacturing Company
   h. Toto
   i. JR Smith
   j. Zurn
   k. Blucher Drains

2.3 WATER CLOSETS –PATIENT ROOMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. American Standard
   b. Sloan
   c. Kohler

1. Description: Wall-mounting, back-outlet, vitreous-china 1.28 GPF plumbing fixtures designed for bedpan washing and flushometer valve operation. Seat shall be solid white Moltex open front with concealed self-sustaining steel check hinge. Fixture shall be supported on chair carrier and fittings.
2.4 WATER CLOSET _PUBLIC TOILETS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. American Standard
   b. Sloan
   c. Kohler

1. Description Wall-mounting, back-outlet, vitreous-china 1.28 GPF fixture designed for flushometer valve operation... Seat shall be solid white Moltex open front with concealed self-sustaining steel check hinge. Fixture shall be supported on chair carrier and fittings.

2.5 WATER CLOSETS (BARIATRIC)

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. American Standard
   b. Zurn
   c. Willoughby
   d. Acorn

2.6 LAVATORIES-WALL MOUNTED

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. American Standard
   b. Sloan
   c. Toto
   d. Karran

1. Description Wall mounting, vitreous-china fixture.
   a. NPS 3/8 chrome-plated copper tubes or flexible connectors supplies with stops.
b. Drain: Grid/Grid with offset

c. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated, cast-brass P-trap; wall escutcheon.

d. Protective Shielding Guard

e. Floor Mounted Chair carrier

2.7 URINALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. American Standard
   b. Sloan
   c. Kohler

1. Description: Wall-mounting, back-outlet, vitreous-china siphon jet ¾” top spud designed for flushometer valve operation 0.5 GPF. Fixture shall be supported on chair carrier with adjustable support plate

2.8 EXAM ROOM SINKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. Karran

1. Description: Undermount seamless integrated Stainless Steel fixture. Supplies ½” chrome plated copper with stops. Drain piping 1 ½” x 2” chrome plated cast brass “P” trap, grid strainer

2.9 PANTRY SINKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. Karran
   b. Elkay
   c. Just
1. Description: Undermount stainless steel fixtures. Supplies ½” chrome plated copper or flexible connectors with stops or valves. Drain piping 1 ½” x 2” chrome plated cast brass “P” trap, grid strainer

2.10 WALL MOUNTED SOILED UTILITY SINKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. American Standard
   b. Sloan

I. Description: Wall-mounting, back-outlet, vitreous-china, flushing-rim, service-sink -type medical plumbing fixture complete with Rim Guard, Faucet, Flusometer, Bed Pan washer and chair carrier.

2.11 SURGICAL SCRUB SINKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   a. Sloan Systems
   b. Continental Metal Products
   c. Steris Amsco Scrup Station
   d. Whitehall/Acorn.
   e. Willoughby

B. Single Station /Double Station to be project specific.

1. Description: Wall-mounting, stainless steel sink- plumbing fixture.
   a. Faucet: Chrome-plated-brass, gooseneck type matching fixture.
   b. Operation: [Foot-pedal] [Knee] [Automatic, hard-wired electric sensor] control.
   c. Supplies: NPS 1/2 chrome-plated copper tubes[ or flexible connectors] with stops.
   d. Drain: Grid strainer NPS 1-1/2 .
   e. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.
   f. Thermostatoc mixing valve required
   g. Fixture Support:
2.12 FLUSH VALVES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following
   b. Sloan
   c. Delany

B. Uptown Campus –Hard Wire or Manual

C. Downtown Campus- Battery or Manual

2.13 FAUCETS

1. Description: Faucet for lavatory-type plumbing fixture. Coordinate faucet inlets with supplies, connectors, and fixture holes; coordinate outlet with spout and fixture receptor.

A. Uptown Campus –Sensor Hard Wire
   a. Chicago.
   b. Sloan

B. Downtown Campus- Sensor Battery
   a. Chicago.
   b. Sloan

C. Manual Faucet-Widespread- Wristblades
   a. T&S Brass.

D. Manual Faucet
   a. T & S Brass
   b. Kohler

E. Metered Faucets-
   a. Chicago
   b. Symmons

2.14 LAMINAR-FLOW FAUCET-SPOUT OUTLET S

A. Laminar-Flow Faucet-Spout Outlets:
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

1. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating, laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.15 JANITORS CLOSET

A. Based-of Design Product: Subject to compliance with requirements, provide product by one of the following: Size to be project specific:
   a. Fiat.
   b. Just

B. Faucet:

Faucet to be polished chrome finish, lever handles, wall brace assembly, ½” NPT female inlets, ¾” male hose thread outlet, integral stop valves, atmospheric vacuum breaker.
   a. Chicago
   b. T&S Brass

2.16 SHOWER VALVE

1. Description: Faucet for shower-type medical plumbing fixtures. Include hot- and cold-water indicators, check stops, and shower head, arm, and flange. Coordinate faucet inlets with supplies.

A. Uptown Campus- Symmons Industries

B. Downtown Campus- Powers

2.17 SHOWER DRAIN BODY

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
   a. Blucher
   b. Zurn.

B. 304 Stainless steel linear shower drain. Grate option to be project specific
2.18 TOILET SEATS

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   b. Church Seats.
   c. Olsonite Corp.

2. Description: Toilet seat for water-closet-type fixture.

2.19 ELECTRIC WATER COOLERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay
   b. Halsey Taylor

B. Complete filtered water cooler and bottle filling station in space saving ADA compliant design

C. Unit shall provide 8.0 GPH of 50 degree water at 90 degree F ambient. Bottle filling unit shall include an electronic sensor for no touch activation.

2.20 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. McGuire Manufacturing Co., Inc.
      b. TRUEBRO, Inc.
   2. Description: Manufactured plastic wraps for covering plumbing fixture [hot-water supply] [hot- and cold-water supplies] and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
2.21 FIXTURE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Zurn Plumbing Products Group; Specification Drainage Operation.
   3. Josam
   4. Wade

C. Water-Closet Supports,
   1. Description: Combination carrier designed for accessible, standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

D. Urinal Supports,
   1. Description: Urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.

E. Lavatory Supports
   1. Description: Type lavatory carrier with concealed arms for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
END OF SECTION 224000
EMERGENCY PLUMBING FIXTURES
SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following emergency plumbing fixtures:
   1. Emergency showers.
   2. Eyewash equipment.
   3. Self-contained eyewash equipment.
   4. Eye/face wash equipment.
   5. Hand-held drench hoses.
   6. Combination units.
   7. Water-tempering equipment.

1.2 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."


D. NSF Standard: Comply with NSF 61, "Drinking Water System Components-Health Effects," for fixture materials that will be in contact with potable water.

1.3 SOURCE QUALITY CONTROL

A. Certify performance of plumbed and self-contained emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.
1.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

B. Electrical-Component Testing: After electrical circuitry has been energized, test for compliance with requirements.

1. Test and adjust controls and safeties.

C. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

D. Report test results in writing.

PART 2 - PRODUCTS

2.1 EMERGENCY SHOWERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guardian Equipment Co

2. Description: Plumbed, [horizontal, wall-mounting] [vertical, ceiling-mounting] [freestanding] emergency shower.
   a. Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1-1/4 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Pull rod or chain.
   d. Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.

B. Emergency Showers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guardian Equipment Co.
2. Description: Plumbed, multiple-spray emergency shower with 8-16 small shower heads or nozzles.
   a. Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1-1/4 minimum chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle or Treadle.

2.2 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Guardian Equipment Co.

2. Description: Plumbed, freestanding, pedestal eye/face wash equipment.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle, Push bar or Treadle.
   d. Receptor: Chrome-plated brass or stainless-steel bowl.
   e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2. Include galvanized-steel indirect connection to drainage system.

B. Eye/Face Wash Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Guardian Equipment Co.

2. Description: Plumbed, accessible, wall-mounting eye/face wash equipment with receptor and wall bracket.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
d. Receptor: [Chrome-plated brass or stainless-steel] [Plastic] bowl.
e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

C. Eye/Face Wash Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guardian Equipment Co.

2. Description: Plumbed, accessible, wall-mounting eye/face wash equipment without receptor and with wall bracket.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

D. Eye/Face Wash Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guardian Equipment Co.

2. Description: Plumbed, adjacent-to-sink, swivel, counter-mounting eye/face wash equipment.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

2.3 HAND-HELD DRENCH HOSES

A. Hand-Held Drench Hoses:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guardian Equipment Co.
   b. .
2. Description: Plumbed, wall-mounting, hand-held drench hose with wall bracket.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   d. Hose: Coiled or plain, rubber or plastic.
   e. Spray Heads: [Single] [Twin].

B. Hand-Held Drench Hoses:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guardian Equipment Co.

2. Description: Plumbed, counter-mounting, hand-held drench hose.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   b. Supply Fitting: NPS 1/2 brass with flow regulator.
   c. Hose: Rubber or plastic.
   d. Control-Valve Actuator: Hand-held squeeze valve.
   e. Spray Heads: Single or Twin.

3. Description: Plumbed, counter-mounting, hand-held drench hose.
   a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   b. Supply Fitting: NPS 1/2 brass with flow regulator.
   c. Hose: Rubber or plastic.
   d. Control-Valve Actuator: Hand-held squeeze valve.
   e. Spray Heads: Single or Twin.

2.4 COMBINATION UNITS
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Guardian Equipment Co.

2. Description: Plumbed, accessible, freestanding, with emergency shower and [eyewash] [eye/face wash] [drench hose] equipment.
a. Piping: Chrome-plated brass or stainless steel.
   1) Unit Supply: NPS 1-1/2 from top or side.
   2) Unit Drain: Outlet at side near bottom.
   3) Shower Supply: NPS 1 with flow regulator and stay-open control valve.
   4) Eyewash, Eye/Face Wash or Drench Hose Supply: NPS 1/2 with flow regulator and stay-open control valve.

b. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
   1) Control-Valve Actuator: Pull rod, Pull chain or treadle.
   2) Shower Head: 8-inch minimum diameter, chrome-plated brass or stainless steel.
   3) Control-Valve Actuator: Paddle or Push bar.
   4) Receptor: Chrome-plated brass or stainless-steel bowl.

c. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   1) Control-Valve Actuator: Paddle or Push bar.
   2) Receptor: Chrome-plated brass or stainless-steel bowl.

d. Hand-Held Drench Hose: With capacity to deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   1) Hose: Rubber or plastic.
   2) Control-Valve Actuator: Hand-held squeeze valve.
   3) Spray Head(s): Single or twin.

2.5 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Leonard Valve Company.
      b. Powers, a Watts Industries Co.
      c. Guardian
2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

   a. Thermostatic Mixing Valve: Designed to provide 85 deg F temperature tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

END OF SECTION 224500
COMPRESSED-AIR EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS
A. Actual Air: Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in acfm.
B. Laboratory Air Equipment: Compressed-air equipment and accessories for nonmedical laboratory facilities.
C. Medical Air Equipment: Compressed-air equipment and accessories for healthcare facilities.
D. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.3 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7
C. All equipment shall be internet ready
1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Laboratory Air System Equipment for Nonmedical Laboratory Facilities: An employer of workers trained and approved by manufacturer.
2. Medical Air System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 99, "Health Care Facilities," for compressed-air equipment and accessories for medical air systems.

F. Comply with UL 544, "Medical and Dental Equipment," for medical compressed-air equipment.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Laboratory and Medical Compressed-Air Service(s): Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Do not proceed with interruption of service without Owner’s permission.
PART 2 - PRODUCTS

2.1 Medical Air Compressors

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
   2. Beacon Medaes

B. Medical Air Compressor System – Scroll

1. Provide a complete medical air source, complying with all relevant requirements of NFPA 99 and supplying medical air continuously for the life of the equipment. The unit shall be manufactured by BeaconMedaes or FO pre-approved equal.

2. Furnish a complete plant consisting of compressors, receiver, air treatment system and controls capable of providing scheduled capacity with one compressor out of service and complying with 3-10 below.

3. System shall be built entirely on a single base or a base which can be separated in the field for rigging. Separable, bases shall be factory prepared. System or system sections shall fit through a standard 36 inch door frame.

4. System shall be completely factory assembled having field connections limited to (1) air inlet line, (1) air delivery line, (1) floor drain, (1) electric power connection, (1) one communication connection, (1) master alarm connection. Systems requiring site assembly are not acceptable except reattachment of sections separated on site at contractor’s convenience.

5. System base, frames, control cabinet and receiver shall all be powder coated for durable and attractive finish.

6. The compressor modules and motors shall be fully isolated from the main compressor base by means of a four point, heavy-duty isolation system providing a minimum of 95% isolation efficiency. System shall be engineered for equal weight distribution between four isolation points. Systems not having this feature shall have an inertia base sized for that system installed at this contractor’s expense.
7. Flexible connections between compressor units and the structure shall be provided for all inlets and outlets. Vibration flexes shall be all metal and of sufficient length to achieve full isolation. Systems using rubber tubing flex connectors with hose clamps are not acceptable. Systems with short flex connections providing only nominal isolation are not acceptable. Inlet flexes shall be corrugated metal with outer stainless braid. Outlet flexes shall be metal and double wall with thermal isolation.

8. Any piping or connection which may exceed 150 degrees F. shall be guarded to prevent contact burns. Belt and fans shall be guarded to prevent worker injury. Hazard labeling alone is not acceptable.

9. The compressors shall be a continuous duty rated scroll type. The design shall be single stage, air-cooled, consisting of one fixed and one orbiting scroll sealed with PTFE tip seals between the scroll halves and rated for 828 kPa (120 PSIG) discharge pressure. Orbiting bearings shall be grease filled. Compressors shall be field serviceable allowing tip seal change and bearing lubrication. Non-field serviceable scroll compressors are not acceptable. Noise level at 3 ft. shall not exceed 70 dB(A) for duplex system, 76 dB(A) for triplex system. Belt tensioning shall be achieved with a sliding motor mounting base adjustable with two tensioning screws. Each compressor unit shall be equipped with a dedicated air cooled aftercooler with separate cooling fan using ambient (not heated) air, the cooler being designed for a maximum approach temperature of 7°C (15°F) when using 37.8°C (100°F) ambient cooling air each being complete with electronic drain valve. Each compressor shall be equipped with a dedicated cooling fan. Designs using compressor cooling air for the aftercooler or aftercooler air for compressor cooling are not acceptable. The discharge piping of each compressor shall incorporate an electronic solenoid valve to prevent reverse rotation of the scroll at shutdown.

10. Control system shall be contained in a cabinet which is factory prepunched for conduit connections. Provide three punches: one for Power In sized per NFPA 70 Article 310 and based on total system amperes, one for communications and one for master alarm wiring, each sized at ½”. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 Medical Device registration. Provide in the control system door:
   a. 16 bit, full color, VGA resolution touch screen display for system functions and system level control.
   b. Separate 16 bit, full color half VGA resolution touch screen for display of compressor unit functions and compressor unit control. These controls shall
provide selector control of Manual (continuous run), Off, Automatic for each compressor unit.

c. A separate disconnect handle with door interlock for each compressor unit (note: for multiplex units greater than triplex, only two disconnect handles shall be required)

d. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.

e. Power On lamp illuminated whenever any disconnect is On.

11. Provide in the control cabinet interior:

a. Full voltage motor starters with overload protection, one per compressor unit.

b. Circuit breaker disconnects, one for each compressor unit operated by the through the door disconnect handle.

c. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.

d. Power distribution terminal block convenient for main power entry.

e. All internal circuit boards and components needed for operation of the control system as described below.

f. Volt free contacts for connection to master alarms.

g. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.

12. The control system shall provide the following functions:

a. Display of pressure, dew point and carbon monoxide level on a single display for at-a-glance checking.

b. Automatic lead/lag sequencing and alternation. Display shall clearly show status of each compressor unit including running unit, next-unit-in-sequence, and units unavailable to run.

c. Runtime hour-meters for each compressor unit.

d. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.

e. When M-O-A selectors are in Manual mode, system shall operate on pressure switch and compressor units shall not run if lead switch is satisfied.

f. Controls shall provide visual and audible alarm indication and isolated contacts for remote alarm for at least Dew Point High, CO High, Lag Compressor in Use, and High Temperature for each compressor unit.

g. Controls shall provide automatic indication of major maintenance intervals and
details of required maintenance kits.

h. Controls shall provide distinct separate indication on the control screens of (1) alarms which shutdown the compressor, (2) alarms which do not shut down the compressor, (3) maintenance notifications.

i. Dryers shall be controlled from control panel with controls integral to the touchscreen system. System shall include maintenance alerts and diagnostics for dryers.

j. Controls shall provide isolated contacts for remote alarms which distinguish between a condition which shuts down the unit, a condition which does not shut down the system and a maintenance alert.

k. Control system shall permit individual test of dew point, CO, lag in use, high temperature and controls fault alarm points from the touchscreen. System shall include low level testing of controls, and of local and connected master (source) alarms.

l. Controls shall permit automatic “bumping” of the compressors to test rotation.

m. Control system shall log and allow review of all alarm and shutdown events.

n. Control system shall log and allow review of all maintenance events.

o. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to deliver air or air of quality required. Control systems which can result in inability to deliver air or air of quality required in event of failure of any single component are not acceptable.

p. Controls shall include an integral webserver using standard Ethernet allowing observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special software are not acceptable.

q. Controls shall provide auto discovery from and of any Total Alert alarm on the same network allowing for system wide linking and inspection of any networked component through any single connection.

13. Compressor motors shall be a NEMA Premium Efficiency rated, open drip proof unit with 1.15 service factor suitable for 208 or 230/460 volt, three phase, 60hz.

14. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.

15. A temperature sensor at the outlet of each compressor cylinder or air-end shall provide a high temperature alarm and shutdown that compressor. Systems employing a single switch for multiple cylinders or air-ends are not acceptable.
16. Provide redundant medical air treatment systems including desiccant dryers, filters, and purifiers sized for NFPA system output. Include dew point and carbon monoxide monitoring. Medical air treatment shall include:

a. Desiccant dryers producing a 10°F (-12°C) pressure dew point. Refrigerant dryers are not acceptable.

b. Dryer purge flow control using an integral dew point based purge control system. Purge controllers using desiccant temperature are not acceptable.

c. 441 transfer valve having two self cleaning ceramic slide plates. Units using multiple solenoids or diaphragm type switching are not acceptable. Valve shall require no periodic service and be covered by a full factory warranty.

d. Mounted coalescing pre-filter rated for 0.01 micron with automatic drain and element change indicator at the inlet to each dryer.

e. Final line filters rated for 1 micron with element change indicators (per NFPA 99 5.1.3.5.8(3)&(4)), duplexed final line regulators, and duplexed safety relief valves shall be factory mounted and piped at the outlet of each dryer.

f. Sensors for dew point and CO sensors shall be provided with a DISS demand check per NFPA 5.1.8.2.4.

17. System piping shall be welded except where unions are required for service or where piping connects to valves or system components. Main flow path joints shall be flanged and provided with seals, using 37° SAE flares suitable for flaretight seals or SAE straight thread with O-ring seal for leak tight connection and ease of replacement or service. Use of NPT fittings shall be minimal.

18. Provide corrosion resistant, powder coated, ASME Coded, National Board Certified receiver rated for a minimum 150 PSIG design pressure. Include a liquid level glass with bead, safety relief valve, manual drain valve, and zero loss tank drain. Systems employing timed solenoid type drain valves are not acceptable.

19. The complete medical air package shall be pre-wired, pre-piped and assembled on one common base with single point connections for electrical, intake air, discharge air, and condensate drains. All piping shall be factory complete including all valves per NFPA 99 Fig. A-5.1.3.5.11.6.
20. The complete medical air system and all electrical components shall be factory pretested prior to shipment.

2.2 OILLESS, RECIPROCATING AIR COMPRESSORS
   A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
      1. BeaconMedaes.

   B. Description: Medical Air Compressor System – Rotary Tooth
      1. Provide a complete medical air source, complying with all relevant requirements of NFPA 99 5.1.3.5 and supplying medical air continuously for the life of the equipment. The unit shall be manufactured by BeaconMedaes or pre-approved equal.
      2. All components are at least duplexed and valved to permit service to any component without interrupting air supply to the facility.
      3. Furnish a complete plant consisting of compressors, receiver, air treatment system and controls capable of providing scheduled capacity with one compressor out of service.
      4. System is modular allowing for ease of shipment and handling on site. All sections are fitted on a standard pallet jack or contain fork lift slots. System is completely factory assembled, requiring only interconnection between modules on site. Systems requiring site assembly other than interconnection are not acceptable (remounting of components removed for shipping is permitted).
      5. Compressor motors shall be a high efficiency TEFC motor with 1.15 service factor suitable for 230 or 460 volt, three phase, 60hz. The motor is equipped with a Y-Delta starter, mounted and wired, to reduce current spikes when the motor is started.
      Specifier: use this paragraph if variable speed drive is chosen:
      5. Compressor motors shall be a high efficiency TEFC VSD motor with 1.15 service factor suitable for 230 or 460 volt, three phase, 60hz. The unit is a variable speed drive compressor with a frequency converter that optimally matches the delivered air flow to the system requirements. The motor speed is automatically adjusted to maintain system pressure within the desired operating band.
      6. The compressor shall be a two-stage, oil-free compressor block, consisting of separate low and high pressure rotary tooth compressor elements flanged to a common step-up gearbox. The compressor elements are air cooled. The high and low compressor elements are supplied with safety relief valves. The first stage air is cooled by an intercooler with moisture trap and automatic drain valve. The second stage air is
cooled by an aftercooler with moisture trap and manual and automatic drain valve. The gearbox oil system includes an oil sump, pump, oil filter, bypass valve, drain connection, sight glass and cooler.

a. The compressor intake is equipped with an air intake filter and integral shutoff/unloading valve. Loading or unloading of the unit is controlled by a pressure transducer which will actuate the loading solenoid valve.

b. The compressor shall be direct driven. Torque is transmitted from the motor to the compressor through a flexible shaft coupling.

c. The air discharge for the compressor module has a pulsation damper, check valve and manual isolation valve.

d. Ventilation for the module is supplied by a radial fan with a separate motor.

e. The compressor control system will display the runtime hours, temperature readouts, pressure readouts, service indicators, safety warnings and safety shutdowns for the compressor module.

f. The compressor shall be TÜV certified ISO 8573-1 Class 0.

g. Compressor modules are fully enclosed with sound attenuated steel panels with full access doors for maintenance and inspection.

7. The compressor modules and motors shall be fully isolated from the main compressor module base by means of a heavy-duty isolation system for a minimum of 95% isolation efficiency.

8. Provide redundant medical air treatment systems including desiccant dryers, filters, and regulators sized for peak calculated demand. Include dew point and carbon monoxide monitoring. Dryer/Control module factory piped and wired in accordance with NFPA 99. Medical air treatment shall include:

a. Desiccant dryers producing a -40°F (-40°C) pressure dew point. Refrigerant dryers are not acceptable or permitted

b. Dryer purge flow control through an integral dew point based purge control system. Purge controllers using desiccant temperature are not acceptable.
c. The inlet to each dryer shall include a 1 micron coalescing filter and a 0.01 micron high efficiency coalescing filter with automatic drain and element change indicator.

d. Duplexed final line filters consist of a 1 micron particulate filter and one active carbon filter, each with element change indicators.

e. Duplexed final line regulators, duplexed safety relief valves, oil indicator, and air sampling port shall be factory mounted and piped.

f. Valving included to allow complete air receiver bypass.

g. Dew point and CO transmitter mounted, pre-piped, and wired with dew point and CO conditions displayed on the central control system. The dew point transmitter probe shall be the ceramic type sensor with system accuracy of minimum $+2 \, ^\circ\text{C}$ for dew point and $\pm 2$ PPM (at 10 PPM) for carbon monoxide. High CO and high dew point conditions shall be indicated with visual and audible alarms.

9. The central control system is NEMA 12, UL labeled, and rated for 115V single phase. The control system shall control multiple compressors and a duplexed desiccant drying system with dew point and CO transmitters. Provide in the control system:

a. Automatic lead/lag sequencing and alternation.

b. Visual and audible reserve unit alarm with isolated contacts for remote alarm.

c. Automatic alternation of all compressors based on a first-on/first-off principle with provisions for simultaneous operation if required, automatic activation of reserve unit if required.

d. Visual and audible alarm indication for high discharge air temperature shutdown with isolated contacts for remote alarm.

e. Automatic restart after voltage failure with simultaneous start prevention.

10. All piping shall be factory complete including all valves per NFPA 99 Fig. A-5.1.3.5.11.6.
11. Provide corrosion resistant, ASME Coded, National Board Certified galvanized receiver rated for a minimum 150 PSIG design pressure. Include a liquid level glass, pressure gauge, safety relief valve, manual drain valve, and an automatic solenoid drain valve. During normal operation the flow of air will travel through the tank to allow water vapor to condense in tank.

2.3 DENTAL COMPRESSED-AIR SYSTEM EQUIPMENT

A. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer’s name; product name or designation> or comparable product by one of the following:

1. Air Techniques.
2. JUN-AIR USA Inc.
3. Kaeser Compressors, Inc.
4. Midmark Corp.; Apollo Dental Products

B. Description: Factory-assembled, -tested, and -packaged; automatic, dental compressed-air system that will deliver air of quality at least equal to intake air; suitable for dental applications and capable of producing air at [80 psig] <Insert pressure>.

1. Air Compressor(s): Oilless reciprocating or scroll] type.
   a. Option: Construction may be oil-free, sliding-vane type.

2. Compressor Controls: Adjustable, tank-mounted, pressure [switches and alternator for duplex air compressors] [switch for simplex air compressor].
3. Check Valves: In discharge piping of each air compressor.
4. Air Filter: Integral with air compressor or separate unit for field installation in compressed-air piping.
5. Dryer: Desiccant type integral with air compressor or separate unit for field installation in compressed-air piping.
6. Dryer: Refrigerated [35 deg F] <Insert temperature> dew point, in cabinet with automatic controls, for remote installation. Include on-off switch, on light, inlet and outlet temperature indicators, high-temperature alarm, and rubber isolators on feet.
7. Receiver: Steel tank rated for at least 100 psig with rubber isolators on feet.
   a. Pressure Regulator: Adjustable.
   b. Safety Valve: ASME relief valve with setting of 100 psig or less.

8. Cabinet: Enameled steel, with control panel with manual on-off switch, on light, and pressure gage.[ Refrigeration-type dryer may be separate with integral cabinet.]

2.4 DENTAL COMPRESSED-AIR EQUIPMENT CONTROL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer’s name; product name or designation> or comparable product by one of the following:

1. Air Techniques.
2. CustomAir; a member of Dental EZ Group.

B. Description: Wall-mounting type with visual indicators to indicate equipment in operation and to perform the following:

1. Shut off dental air equipment.
2. Shut off water supply to dental air equipment. Include solenoid-operated valve for installation in water piping.

C. Control panels may be combined with dental vacuum system equipment control panels in single dental equipment control panels.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
2.6 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL COMPRESSED-AIR EQUIPMENT

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Medical Compressed-Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air equipment concurrently with tests, inspections, and certification of [medical vacuum equipment] [medical vacuum piping] [medical compressed-air piping] [and] [medical gas piping] systems.

2. Preparation: Perform medical compressed-air equipment tests according to requirements in NFPA 99 for the following:
   a. Air-quality purity test.
   b. System operation test.

3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical compressed-air equipment.

4. Replace damaged and malfunctioning controls and equipment.

5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

E. Components will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.
END OF SECTION 226119
SECTION 226219 - VACUUM EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - MATERIALS

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS
A. Actual Air: Air delivered at vacuum producer inlet. Flow rate is air measured in expanded cfm.
B. HVE: High-volume oral evacuation for dental applications in healthcare facilities.
C. Laboratory Vacuum Equipment: Equipment and accessories for nonmedical laboratory facilities.
D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
E. Medical vacuum equipment includes [medical vacuum] [WAGD evacuation] [dental vacuum] [HVE] [and] [healthcare laboratory vacuum] equipment and accessories for healthcare facilities.
F. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.3 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design vacuum equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Seismic Performance: Vacuum equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[ and the unit will be fully operational after the seismic event]."

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Wiring Diagrams: For power, signal, and control wiring.

B. Delegated-Design Submittal: For vacuum-producing equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of supports.
2. Design Calculations: Calculate requirements for selecting vibration isolators[ and seismic restraints] and for designing vibration isolation bases.

C. Seismic Qualification Certificates: For vacuum producers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

E. Operation and Maintenance Data: For vacuum equipment to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
1. Laboratory Vacuum System Equipment for Nonmedical Laboratory Facilities: An employer of workers trained and approved by manufacturer.

2. Medical Vacuum System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization an NRTL, and that is acceptable to authorities having jurisdiction.

   1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 99, "Health Care Facilities," for vacuum equipment and accessories for medical vacuum systems.

F. Comply with UL 544, "Medical and Dental Equipment," for medical vacuum equipment.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Laboratory and Medical Vacuum Service(s): Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

   1. Do not proceed with interruption of service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

Determine the size of the medical vacuum plant required and place on the medical vacuum schedule.
2.1 CLAW VACUUM PUMPS

A. Provide a complete medical vacuum source, complying with NFPA 99 in all respects, as specified and scheduled and as manufactured by Beacon Medaes or pre approved equal. Pumps shall be non contacting claw style rotary pumps as manufactured by Beacon Medaes or pre-approved equal. Provide in the control system a single Variable Speed Drive Inverter and separate across the line motor contactors. One pump normally runs on the variable speed and others as required will run across the line.

B. All components shall be at least duplexed and valved (or check valved as provided in NFPA-99) to permit service to any component without interrupting vacuum supply to the facility during any maintenance operation or any condition of single fault failure. Each pump exhaust shall be isolated by a ball valve for service isolation.

C. Furnish complete plant consisting of pumps, receiver and controls capable of providing the scheduled capacity with one pump out of service. All capacities will be indicated in SCFM at 19 inches HG.

D. System shall be built entirely on a single base or a base which can be separated in the field for rigging. If separable, bases are to be factory prepared for separation. System or system sections shall fit through a standard 36 inch door frame.

E. System piping shall use o-ring sealed flanges and SAE O ring or flare fittings to minimize leaks and allow easy repair. Valves shall be butterfly or ball type, positive seal with three piece disassembly.

F. System shall be completely factory assembled. Field connections shall be limited to (1) vacuum inlet line, (1) outlet, and (1) electrical conduit and power. Systems requiring site assembly are not acceptable except reattachment of sections separated on site for convenience of handling.

G. System base, frames, control cabinet, piping and receiver shall be powder coated for durable and attractive finish.

H. Each pump shall include factory installed corrugated metal inlet and outlet flex connectors. Systems employing plastic or rubber hoses for flex connectors are not acceptable.

I. Provide continuous duty rated rotary claw pumps having friction free construction with non-contacting rotors, the air end being oil free and requiring no sealants. Each pump shall be provided with a single lubricated gearbox requiring oil change not more often than annually. MGEM shall offer a testing service for pumps oil to allow less frequent changes. Pumps shall be provided with exhaust silencer. Each pump shall be equipped with high vacuum
shutdown and high temperature shutdown. Provide in the control system a single Variable Speed Drive Inverter and separate across the line motor contactors. One pump shall normally run with variable speed and others as required shall run across the line.

J. Each pump shall be direct or close coupled to a NEMA rated Premium Efficiency TEFC motor with a service factor of 1.15.

K. Control system shall be contained in a cabinet which shall be factory prepunched for conduit connections. Provide three punches: one for Power In sized per NFPA 70 Article 310 and based on total system amperes, one for communications and one for master alarm wiring, each sized at ½”. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 (Medical Device) registration. Provide in the control system door:

   a. 16 bit, full color, VGA resolution touch screen display for system functions and system level control.
   b. Separate 16 bit, full color half VGA resolution touch screens for display of pump functions and pump control. These controls shall provide selection of Manual (continuous run), Off, Automatic for each pump.
   c. A separate disconnect handle with door interlock for each pump.
   d. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.
   e. Power On lamp illuminated whenever any disconnect is On.

L. Provide in the control cabinet interior:

   a. Full voltage motor starters with overload protection, one per pump.
   b. Circuit breaker disconnects, one for each pump operated by the through the door disconnect handle.
   c. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.
   d. Power distribution terminal block convenient for main power entry.
   e. All internal circuit boards and components needed for operation of the control system as described below.
   f. Volt free contacts for connection to master alarms.
   g. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.

M. The control system shall provide the following functions:

   a. Display of vacuum and VSD speed on a single display for at-a-glance checking.
b. Automatic lead/lag sequencing and alternation. Display shall clearly show status of each pump including running unit, next-unit-in-sequence, and units unavailable to run.

c. Runtime hour-meters for each pump.

d. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.

e. When M-O-A selectors are in Manual mode, system will operate on vacuum switch and pump will not run if lead switch is satisfied.

f. Controls provide visual and audible alarm indication and isolated contacts for remote alarm for at least Lag Pump in Use, and High Temperature for each pump.

g. Controls shall provide automatic indication of major maintenance intervals and details of required maintenance kits.

h. Controls shall provide distinct separate indication on the control screens of 1) alarms which shutdown the pump, 2) alarms which do not shut down the pump, 3) maintenance notifications.

i. Controls shall provide isolated contacts for remote alarms which distinguish between a condition which shuts down the unit, a condition which does not shut down the system and a maintenance alert.

j. Control system shall permit individual test of lag in use, high temperature and controls fault alarm points from the touchscreen. System shall include low level testing of controls, local and connected master (source) alarms.

k. Controls shall permit automatic “bumping” of the pumps to test rotation.

l. Control system shall log and allow review of all alarm and shutdown events.

m. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to provide vacuum. Control systems which fail to provide vacuum in event of any single component failure are not acceptable.

n. Controls shall include an integral webserver using standard Ethernet to allow observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special software are not acceptable.

o. Controls shall provide auto discovery from and of any Total Alert alarm on the same network allowing for system wide linking and inspection of any networked component through any single connection.

N. The complete medical vacuum system and all electrical components shall be factory pre-tested prior to shipment by the MGEI.

O. The manufacturer shall supply the services of a factory trained, factory authorized technical representative, as required, to check installation, startup system and instruct operating personnel in the operation and maintenance of the system. Supplier shall have a factory trained, factory authorized service organization available 24 hours a day, 365 days a year.
P. The entire system shall be covered by factory warranty for thirty months from shipment.

2.2 Medical/WAGD Vacuum Pumps – Liquid Ring

A. Provide a complete medical vacuum source, complying with NFPA 99 5.1.3.6 in all respects, as specified and scheduled on the drawings and as manufactured by BeaconMedaes or Gardner Denver Nash.

B. All components shall be at least duplexed and valved (or check valved as provided in NFPA-99) to permit service to any component without interrupting vacuum supply to the facility during any maintenance operation or any condition of single fault failure. Each pump exhaust shall be isolated by a union fitting permitting capping for service removal.

C. Furnish complete plant consisting of pumps, receiver and controls capable of providing the scheduled capacity with one pump out of service. All capacities will be indicated in SCFM at 19 inches HG.

D. System shall be completely factory assembled, requiring only interconnection between modules on site. Systems requiring on site assembly other than interconnection are not acceptable (replacement of components removed for shipping is permitted).

E. Each pump will be direct or close coupled to a NEMA rated High Efficiency TEFC motor with a service factor of 1.15.

F. Each pump will include inlet and outlet flex connectors supplied by the MGEM.

G. The complete control system and all electrical components shall be UL labeled. The control system shall provide:
   a. Automatic lead/lag sequencing including adjustable minimum run timers which adaptively optimize the number of pump starts based on demand.
   b. Circuit breaker disconnects for each vacuum pump with external operators. Units with fuses instead of circuit breakers in motor circuit are not acceptable. The control system shall include an automatic minimum run time adjustment to automatically adjust run time based on demand.
   c. Full voltage motor starters with overload protection.
   d. Redundant 120 volt control circuit transformers.
   e. Visual and audible reserve unit alarm with isolated contacts for remote alarms and audio cancel.
f. Control cabinet shall have lighted HOA selector switches

g. Panel mounted vacuum gauge.

h. Runtime hour-meter for each pump.

H. Provide oil-free, single-stage positive displacement, and non-pulsating liquid ring type pumps. The pump will be fitted with mechanical seals. Each pump will be of all iron construction with a bronze or stainless rotor and carbon steel shaft. Maintenance intervals are calendar based and there is no hours based maintenance. Under normal operation, system shall minimize fresh seal water required. System shall include reservoir sufficient for up to 48 hours operation without fresh water supply. System is self contained. Provide BeaconMedaes systems utilizing NASH pumps or preapproved equal.

I. The complete medical vacuum system and all electrical components shall be factory pre-tested prior to shipment by the MGEM.

2.3 MEDICAL VACUUM EQUIPMENT ALARM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers.

1. Beacon Medaes.

B. General Requirements for Medical Vacuum Equipment Alarm System: Compatible alarm panels, sensing devices, and other related components as required by NFPA 99 for [Level 1] [Level 2] [Level 3] alarm systems.

C. Components: Designed for continuous service and to operate on power supplied from [120] [240] [277]-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Transducer Sensors: Sensors to be located in alarm panels with sensors to be connected to alarm panel with copper tubing.

1. Vacuum Switches: 0- to 30-in. Hg vacuum operating range.

E. General Requirements for Medical Vacuum Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting: [Exposed, surface] [Recessed] installation.

2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.
F. Local and Master Alarm Panels: Separate trouble alarm signals and pressure gages to indicate function of medical vacuum equipment when the following conditions exist:

1. Medical Vacuum Equipment: Drops below 12-in. Hg, backup vacuum producer is in operation, and high water level is in receiver.
2. WAGD Evacuation Equipment: Drops below 12-in. Hg vacuum, backup vacuum producer is in operation, and high water level is in receiver.
3. Dental Vacuum Equipment: Drops below 6-in. Hg vacuum, backup vacuum pump is in operation, and high water level is in receiver.
4. Medical Laboratory Vacuum Equipment: Drops below 10-in. Hg vacuum, backup vacuum pump is in operation, and high water level is in receiver.

2.4 DENTAL VACUUM SYSTEM EQUIPMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.

1. Air Techniques.
2. CustomAir; a member of DentalEZ Group.
3. Gardner Denver ELMO- Rietschle by Sherman Engineering
4. Gardner Denver Nash

B. Description: Factory-assembled, -tested, and -packaged; [simplex] [duplex]; automatic, dental vacuum system; suitable for dental applications and capable of producing not less than 12-in. Hg vacuum.

1. Simplex Vacuum Pump: For mounting on base or on floor.
   a. Vacuum Pump: Brass water-injection or liquid-ring type with rubber isolators on feet. Include fitting and tubing for circulation of approximately 80 percent of water through vacuum pump.
   b. Cabinet: Enamel steel; open construction[ with sound-insulated cover]. Include control panel with adjustable vacuum control, manual on-off switch, on light, and vacuum gage.
   c. Dual-Voltage Control: Conversion unit for connection to 208- or 230-V ac power.
   d. Water Filter: For installation in inlet water supply.
   e. Backflow Preventer: Integral with unit or separate reduced-pressure-zone type for field installation in inlet-water supply piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for separate backflow preventers.
   f. Check Valve: For installation in vacuum pump suction.
   g. Vacuum Relief Valve: For installation in vacuum pump suction.
h. Air-Water Separator: With integral control to release wastewater when unit is shut off.

i. Waste Muffler: For installation in vacuum pump’s waste piping.

2. Duplex Vacuum Pumps: For mounting on base or on floor.
   a. Vacuum Pumps: Brass water-injection or liquid-ring type with rubber isolators on feet. Include fitting and tubing for circulation of approximately 80 percent of water through vacuum pump.
   b. Cabinet: Enameled steel; open construction with sound-insulated cover. Include control panel with alternator, adjustable vacuum control for each vacuum pump, manual on-off switches, on light, and vacuum gage.
   c. Dual-Voltage Control: Conversion unit for connection to 208- or 230-V ac power.
   d. Water Filter: For installation in inlet water supply.
   e. Backflow Preventer: Integral with unit or separate reduced-pressure-zone type for field installation in inlet-water supply piping. Refer to Division 22 Section “Sanitary Waste Piping Specialties” for separate backflow preventers.
   f. Check Valves: For installation in each vacuum pump suction.
   g. Vacuum Relief Valves: For installation in each vacuum pump suction.
   h. Air-Water Separators: With integral control to release wastewater when unit is shut off.
   i. Waste Mufflers: For installation in each vacuum pump’s waste piping.

2.5 DENTAL VACUUM EQUIPMENT CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
   1. Air Techniques.
   2. CustomAir; a member of DentalEZ Group.

B. Description: Wall-mounting type with visual indicators to indicate equipment in operation and to perform the following:
   1. Shut off dental vacuum equipment.
   2. Shut off water supply to dental vacuum equipment. Include solenoid-operated valve for installation in water piping.
C. Control panels may be combined with dental air system equipment control panels in single dental equipment control panels.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.2 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL VACUUM EQUIPMENT

A. Testing Agency Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Medical Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum equipment concurrently with tests, inspections, and certification of [medical compressed-air equipment] [medical compressed-air piping] [medical vacuum piping] [and] [medical gas piping] systems.
2. Preparation: Perform medical vacuum equipment tests according to requirements in NFPA 99 for the following:
   a. System operation test.
3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical vacuum equipment.
4. Replace damaged and malfunctioning controls and equipment.
5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

   a. Inspections performed.
   b. Procedures and materials used.
   c. Test methods used.
   d. Results of tests.

E. Components will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 226219
GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Carbon dioxide piping
2. Helium Piping
3. Nitrogen
4. Nitrous oxide
5. Oxygen
6. Medical surgical vacuum piping
7. Waste anesthetic gas disposal piping
8. Dental vacuum piping
9. Oral-evacuation piping and specialties, designated "HVE"
10. Healthcare laboratory vacuum piping
11. Compressed-air piping
12. Medical air piping
13. Gas-powered-tool air piping

1.2 SUBMITTALS

A. Product Data: For the following:

1. Tubes and fittings.
2. Medical Valves and valve boxes.
3. Medical gas service connections.
4. Patient service consoles.
5. Medical nitrogen pressure control panels.
6. Medical gas alarm system components.
7. Gas cylinder storage racks.
8. Medical vacuum service connections and vacuum-bottle brackets.

B. Shop Drawings: Diagram power, signal, and control wiring.
C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements. Installer to use performance testing record from ASSE 6000.

D. Qualification Data: For Installer and testing agency.

E. Brazing certificates.

F. Manufacturer Seismic Qualification Certification: (Beacon Medaes is only company seismic qualified). Submit certification that gas manifolds and bulk gas storage tanks, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

G. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For specialty and medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. NFPA Compliance:
   1. Comply with NFPA 50 "Bulk Oxygen Systems at Consumer Sites," for bulk oxygen storage tanks and NFPA 55 Compressed Gases and Cryogenic Fluids


H. UL Compliance:
   1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections. (Present location 5’-0” above floor)
   2. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.4 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of specialty gas piping for non healthcare laboratory facilities and prepare test reports.

B. Perform field tests and inspections of specialty gas piping for non healthcare laboratory facilities and prepare test reports.

C. Perform tests according to the requirements in NFPA99,2005 and ASSE standard #6010

D. Laboratory cannot share anything from Level 1 systems or entire system must be converted into Level 1

E. Tests and Inspections:
1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 1 ½ times above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.

3. Inspect specialty gas regulators for proper operation.

1.5 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.

2. Perform tests according to the requirements in NFPA 99, 2005 and ASSE standard #6020 and ASSE 6030.

3. System Verification: Comply with requirements in NFPA 99-2005 for verification of medical gas piping systems and inspections:

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above. Any component that is not corrected after the first failure must be replaced.
E. All documents to be submitted to FO on the day of service.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: All medical gas piping (oxygen, compressed air, nitrous oxide, piping) shall be hard tempered type "K" or "L" OXY/MED copper tubing with wrought copper fittings. All joints shall be brazed using silver solder. Brazing shall be performed by certified brazers. Brazed joints shall be performed while the piping system is purged with nitrogen as indicated in NFPA 99/2005 paragraph 5.1.10.5.

B. Vacuum and WAGD Type "K" or "L" hard drawn seamless copper tube ASTM B 88 to conform to NFPA 5.1.10.2.1, with wrought copper fittings. All joints shall be brazed using silver solder.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general duty brazing.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, full port 3-piece body, brass or bronze, dual port
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amico Corporation
   b. BeaconMedaes.
   c. Tri-Tech

   2. Pressure Rating: 300 psig minimum.
   4. Seats: PTFE or TFE.
   5. Handle: Lever type with locking device.
   6. Stem: Blowout proof with PTFE or TFE seal.
8. Dual Port

C. Check Valves: In-line pattern, bronze, brazed joints.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BeaconMedaes.
      b. Conbraco Industries, Inc.
   2. Pressure Rating: 300 psig minimum.

D. Zone Valves: Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BeaconMedaes.

   Shutoff Valves shall be full-port with three-piece construction, have Teflon seals and be designed for working pressures of 600 psi or 29” Hg vacuum. The valves shall have a blowout proof stem, be cleaned for oxygen service, have a corrosion-resistant bronze body and require only one-quarter turn to completely open or close. Valves shall be available in ½” through 4” diameter sizes with Type K copper tubing extensions brazed to flanges and include a 1/8” NPTF dual port, sealed with Brass HEX HD plug on the upstream and downstream extension. Optional locking handles are to be available for sizes ½” through 4”.

E. Zone Valve Boxes:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BeaconMedaes.

   Valve Box shall be constructed 18 gauge steel with white epoxy finish with two galvanized steel brackets that anchors the box to the wall. Valve box shall include a 1-½” line pressure monitoring gauge, be available to accommodate one to six valves of various sizes. Shall be labeled for gas identification, and be enclosed with a window displaying the following notice: “CAUTION: Medical Gas Shutoff Valves. Do Not Close Except in Emergency.” The finish frame is constructed of extruded, etched, and anodized aluminum. Concealed mounting screws secure the finish frame to the valve box. The window shall be tinted, shatter resistant, rigid vinyl with pull-ring.
Chrome plated valves are not acceptable. Installer shall provide identification for valves in box to identify room name and room numbers.

2. Interior Finish: Factory-applied white enamel.

F. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BeaconMedaes.
   b. Tri Tech medical
2. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
3. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4, ASTM B 819, copper tubing with NPS 1 minimum ball valve and plugged inlet.
4. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig.
5. Instrumentation: Pressure gage.

G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

H. Pressure Regulators: [Bronze] [Stainless-steel] body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for [250-psig] minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.4 MEDICAL GAS SERVICE CONNECTIONS- (Series B Technology)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. BeaconMedaes.

B. General Requirements for Medical Gas Service Connections,: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   1. Roughing-in Assembly:
a. Steel outlet box for recessed mounting and concealed piping.

b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.

c. Double seals that will prevent gas leakage.

d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:

a. Brass housing with primary check valve.

b. Double seals that will prevent gas leakage.

c. Cover plate with gas-service label.

3. D.I.S.S. Service Connections: DISS Medical gas outlets shall be gas specific for the services indicated and accept only corresponding DISS nuts and nipples. Outlet shall be UL listed, CSA certified and fully compliant with the latest edition of NFPA99. All outlets shall be 100% tested for flow, leaks and connector attachment.

4. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

5. Cover Plates: One piece, anodized aluminum and permanent, color-coded, identifying label matching corresponding service.

6. Ceiling Outlets shall be DISS Key Style and shall include hose drops terminating with quick connect and/or DISS check units. Hoses shall terminate 6’ 4” AFF and include Hose Retracor Kits

2.5 MEDICAL NITROGEN PRESSURE CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Manufacturer must have replacement parts readily available

1. BeaconMedaes.

B. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
2.6 MEDICAL GAS ALARM SYSTEMS

A. General Requirements – BeaconMedaes TA2 Series Alarm panels.

1. All Medical Gas Alarm panels shall be UL listed as an assembly and shall include factory wiring, transformers, and circuitry requiring only 115 or 230 volt primary power.

2. Alarm panels shall meet the FCC Part 15, Subpart B and ICES-003 to reduce possibility of magnetic radiation interference with other equipment.

3. The alarm shall arrive on the job site pre-configured as shown on the drawings and schedules or shall be configured by MGEM personnel at no additional charge.

4. Alarm shall supervise its wiring to sensors and switches, indicating at the relevant panel(s) if any wire is cut, disconnected or open.

5. Each signal will include an indicator light to signify the condition monitored. Activation of any switch will light its LED and actuate the audio alarm.

6. Each panel shall include a power on indicator and test function for testing all modules electrically.

7. Alarms shall include features permitting field adjustment of alarm volume and display intensity.

8. Termination of alarm wiring to be done by or under supervision of manufacturer of alarm.

9. Network communication implementation provides browse, download, configure, and troubleshooting of Master Alarms and Area Alarms with a personal computer that is
connected to the facility’s Ethernet. The alarm’s Web pages are built-in; no setup is required.

10. Alarms shall be compatible with Johnson Control Metasys Building Management System N2 protocol or building information systems.

11. Alarm shall be factory capable of connection to the facility’s Ethernet network. Alarms shall require no special programming or software to allow remote interrogation through any computer on the same intranet. MGEM personnel shall be responsible for alarm configuration at no additional charge.

12. Provide owner with any software and manuals required for interface at time of commissioning at no additional charge.

B. Master Alarms

1. Furnish exact duplicate Master Alarm Panels at two locations or as shown on the plans.

2. Wire the master alarm panel’s alarms directly to the individual sensors/switches, furnishing duplicate sensors/switches as required for compliance with NFPA 99 5.1.9.2.4. Low voltage shielded wire shall be provided and installed by this contractor.

3. Alarms shall be tested, labeled and fully operational for owner. Where alarm configuration in software is necessary, it shall be provided by MGEM representative at no additional charge.

4. Provide alarm points as indicated in NFPA 99 Table A.5.1.9.2. and as detailed on drawings.

5. Master alarm panels shall be fully compatible with owner’s Ethernet network as supplied.

C. Area Alarms

1. Each area alarm shall include a rough in including power supply, a sensor for each specific gas, and one digital display for each specific gas.

2. The power supply shall be of the universal switching type (100-250VAC, 50/60/440Hz, 120-300VDC). Power supply shall be fused to protect the system from voltage and amperage surges. Alarm shall clearly indicate when power is on.

3. The area alarm shall provide an audible and visual signal when an advisory or a fault signal is received. Signal limits shall be factory set, with the ability to be field adjusted without the use of tools.

4. Each panel shall provide continuous digital display of the vacuum or pressure, high pressure LED indicator, low pressure (or vacuum) LED indicator and a Normal LED
indicator.
5. The Sensor shall contain a transducer to drive the Digital Module. Sensors shall be gas specific, provided with integral demand checks and capable of mounting directly in the gas pipeline system above the ceiling. Connectors shall be provided for attaching field wiring.
6. The sensor shall include an indicator on the sensor housing allowing visual confirmation of sensor operation from floor level when the sensor is in the ceiling on the piping.
7. All area alarm sensors should be mounted locally inside the panel enclosure and connected to the pipeline via pipe, not wire.
8. Furnish and install the alarm. Coordinate the power wiring with Division 16. Low voltage shielded signal wiring will be provided and installed by this contractor.
9. Termination of signal wiring at alarm location will be done by or under supervision of manufacturer of alarm.

2.6 GAS CYLINDER STORAGE RACKS

A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.

B. Freestanding Storage Racks: Fabricate floor stanchions and racks as indicated or provide equivalent manufactured storage racks.

C. Separate stanchions are to be provided for full and empty cylinders.
2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
   1. Finish: Polished chrome-plated

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.9 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.
2.10 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99/2005 5.1.11
CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES
SECTION 226600 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - MANUFACTURERS

A. PP Drainage Pipe and Fittings
   a. IPEX Inc.
   b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
   c. Sloane, George Fischer Inc.
   d. Town & Country Plastics, Inc.
   e. Zurn Plumbing Products Group; Chemical Drainage Systems.

B. PVC Drainage Pipe and Fittings: ASTM D 2665, pipe and drainage-pattern fittings
   a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
   b. Watts Industries (Canada) Inc.
   c. Zurn Plumbing Products Group; Chemical Drainage Systems.

C. PVDF Drainage Pipe and Fittings:
   a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
   b. Watts Industries (Canada) Inc.
   c. Zurn Plumbing Products Group; Chemical Drainage Systems.

D. PE Drainage Pipe and Fittings:
   a. ISCO Industries, LLC.
   b. Performance Pipe; a division of Chevron Phillips Chemical Company LLC.

E. Stainless-Steel Drainage Pipe and Fittings: See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain subparagraph and list of manufacturers below. See Division 01 Section “Product Requirements.”
   a. Josam Company; Blucher-Josam Div.

1.2 DOUBLE-CONTAINMENT PIPE AND FITTINGS

1. Ameron International; Fiberglass Pipe Group.
2. Eslon Thermoplastics; Guardian Div.
3. Fischer, George Inc.
4. Flo Safe, Inc.
5. IPEX Inc.
6. IPEX Inc.; Guardian Div.
7. NIBCO INC.
8. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
10. Smith Fibercast.
11. Thermacor Process, L.P.

1.3 PIPING SPECIALTIES

A. Plastic Dilution Traps:
   a. IPEX Inc.
   b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
   c. Sloane, George Fischer Inc.
   d. Town & Country Plastics, Inc.

B. High-Silicon-Iron Dilution Traps:
   a. Flowserve Corporation; Foundry Operations.

C. PP Floor Drains:
   a. IPEX Inc.
   b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
   c. Schier Products Company.
   d. Sloane, George Fischer Inc.
   e. Town & Country Plastics, Inc.

1.4 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks
   a. Chem-Tainer Industries.
   b. IPEX Inc.
   c. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
   d. Schier Products Company.
1.5 NEUTRALIZATION SYSTEMS

A. Plastic-Tank Neutralization Systems:
   a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
   b. Town & Country Plastics, Inc.

B. Ceramic-Tank Neutralization Systems <Insert drawing designation>:
   a. Koch Knight LLC.

1.6 LEAK-DETECTION SYSTEMS

A. Leak-Detection Systems
   a. Asahi/America.
   b. Flo Safe, Inc.
   c. Perma-Pipe, Inc.; Subsidiary of MFRI, Inc.
   d. Tyco Thermal Controls LLC; Tracer Div.

1.7 SLEEVE SEALS

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.

PART 2 - PRODUCTS

2.1 SINGLE-WALL PIPE AND FITTINGS

A. PE Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.

B. PVC Drainage Pipe and Fittings: ASTM D 2665, pipe and drainage-pattern fittings.

C. PVDF Drainage Pipe and Fittings: ASTM F 1673, Schedule 40, pipe and drainage-pattern fittings. Include fittings with [fusion] [fusion- and mechanical] [mechanical]-joint ends.

D. Stainless-Steel Drainage Pipe and Fittings: ASME A112.3.1, ASTM A 666, Type 316L, stainless-steel pipe and drainage-pattern fittings; with socket and spigot ends for gasket joints; and having piping manufacturer’s FPM lip-seal rubber gaskets shaped to fit socket groove, with plastic backup ring.

E. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.2 DOUBLE-CONTAINMENT PIPE AND FITTINGS

A. Description: Factory-fabricated, double-wall pipe and fittings. Sizes indicate carrier-pipe size; with carrier (inner) pipe and fittings; annular-space, carrier-pipe supports; containment (outer) pipe and fittings; and joining materials and fasteners. Include manufacturer’s standard piping materials according to the following:

1. PE, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.


3. PP/PVC, Double-Containment Drainage Pipe and Fittings:
c. PVC Containment Pipe: ASTM D 2665, PVC pipe.
d. PVC Containment Pipe Fittings: ASTM D 2665, PVC drainage pattern.

   b. Fittings: ASTM F 1673, Schedule 40 drainage pattern complying with ASTM D 3311.

5. PVDF/PVC, Double-Containment Drainage Pipe and Fittings:
   a. PVDF Carrier Pipe: ASTM F 1673, Schedule 40; made of ASTM D 3222, PVDF resin.
   b. PVDF Carrier-Pipe Fittings: ASTM F 1673, Schedule 40 drainage pattern complying with ASTM D 3311; made of ASTM D 3222, PVDF resin.
   c. PVC Containment Pipe: ASTM D 2665, PVC pipe.
   d. PVC Containment Pipe Fittings: ASTM D 2665, PVC drainage pattern.

   B. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

2.3 JOINING MATERIALS

A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
D. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

E. Fiberglass-Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 PIPING SPECIALTIES

A. Plastic Dilution Traps:
   1. Material: Corrosion-resistant PP, with removable base.
   2. End Connections: Mechanical joint.
   3. Dilution Tanks: 1-gal. capacity, with clear base unless colored base is indicated; with two NPS 1-1/2 top inlets and one NPS 1-1/2 side outlet.
   4. Small Dilution Jars: 1-pint capacity, with clear base unless colored base is indicated; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.
   5. Large Dilution Jars: 1-quart capacity; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.

B. High-Silicon-Iron Dilution Traps:
   2. Size: NPS 1-1/2 or NPS 2 as required for fixture and waste.
   3. End Connections: Mechanical.

C. PP Floor Drains
   1. Body: With 7- to 9-inch top diameter, with flashing flange and weep holes; and with [flashing clamp] [basket strainer] [funnel attachment] [and] [trap-primer connection].
   2. Outlet: Bottom, to match connecting pipe, with NPS 2, NPS 3, NPS 4, or NPS 6 outlet as indicated.
   3. .

D. PP Sink Outlets:
   1. Description: NPS 1-1/2, with clamping device, stopper, and 7-inch high overflow fitting.

2.5 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks
1. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.

   a. Material: [HDPE] [HDPE or ASTM D 4101, PP] [ASTM D 4101, PP].
   b. Tank Capacity:
   c. Dip Tube: On outlet pipe instead of inlet pipe.
   d. Extension: HDPE, PE, or PP.
   e. Traffic Cover: [Light-duty] [Heavy-duty pedestrian or light-duty vehicular, steel plate over] plastic, bolted.
   f. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch diameter.
   g. Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch diameter.

2.6 NEUTRALIZATION SYSTEMS

A. Plastic-Tank Neutralization Systems:

1. Description: Automatic system for neutralizing chemical waste.

   a. Controls: Factory-wired and -tested, 120-V ac, to operate probes, control valves, and metering pumps and to monitor pH of effluent; with wiring and electrical-power terminals.
   b. Panel: NEMA 250, Type 4X enclosure, unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, but not less than the following:

      1) Power light and on/off switch.
      2) pH analyzer with meter and high- and low-pH indicators.
      3) Low caustic- and acid-solution level indicators.
      4) Alarm horn with silencer and reset switch.
      5) Agitator running light with on/off switch.
      6) Running lights with on/off switches for caustic- and acid-solution pumps.

   c. Strip chart recorder with capacity for 30-day record.
   d. Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.
   e. Interceptor Tank: Same material as mixing tank; with removable, gastight cover; and sidewall inlet and outlet piping connections.
f. Neutralization Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and vent connection in sidewall or top.

1) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch diameter.
2) Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch diameter.

g. Mixing Tank: With removable, gastight cover; sidewall inlet and outlet piping connections; vent connection in sidewall or top; neutralizing-solution piping connections; and openings in top for probe and agitator.

1) Material: HDPE or ASTM D 4101, PP.
2) pH Probe: Type and length suitable for mixing-tank size.
3) Agitator: Electric, with stainless-steel shaft and propeller.

h. Caustic-Solution Storage Tank: PP.

1) Caustic Chemical: Sodium hydroxide solution.

i. Acid Storage Tank: PP.

1) Acid Chemical: Sulfuric acid solution.

j. Metering Pumps: Types suitable for neutralizing solutions.
k. Sampling Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and opening in top for probe.

1) pH probe: Type and length suitable for sampling-tank size.

B. Ceramic-Tank Neutralization Systems:

1. Description: Automatic system for neutralizing chemical waste.

a. Controls: Factory-wired and tested, 120-V ac, to operate probes, control valves, and metering pumps and to monitor pH of effluent; with wiring and electrical-power terminals.

b. Panel: NEMA 250, Type 4X enclosure, unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, including the following:
1) Power light and on/off switch.
2) pH analyzer with meter and high- and low-pH indicators.
3) Low caustic- and acid-solution level indicators.
4) Alarm horn with silencer and reset switch.
5) Agitator running light with on/off switch.
6) Running lights with on/off switches for caustic- and acid-solution pumps.

c. Strip chart recorder with capacity for 30-day record.

d. Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.

e. Interceptor Tank: Same material as mixing tank; with removable, gastight cover; and sidewall inlet and outlet piping connections.

f. Neutralization Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and vent connection in sidewall or top.

1) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch diameter.
2) Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch diameter.

g. Mixing Tank: With removable, gastight cover; sidewall inlet and outlet piping connections; vent connection in sidewall or top; neutralizing-solution piping connections; and openings in top for probe and agitator.

1) Material: Clay, vitrified into ceramic unit.
2) pH Probe: Type and length suitable for mixing tank size.
3) Agitator: Electric, with stainless-steel shaft and propeller.

h. Caustic-Solution Storage Tank: PP.

1) Caustic Chemical: Sodium hydroxide solution.

i. Acid Storage Tank: PP.

1) Acid Chemical: Sulfuric acid solution.

j. Metering Pumps: Types suitable for neutralizing solutions.

k. Sampling Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and opening in top for probe.
1) pH probe: Type and length suitable for sampling-tank size.

2.7 MANHOLES

A. Description: ASTM F 1759, fabricated from PE components. Include bottom, sidewalls, and top sections; corrosion-resistant, manhole frame and cover; fusion or other watertight joints; and design to prohibit flotation.

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

   a. Ayer Sales, Inc.
   b. ISCO Industries, LLC.
   c. Performance Pipe, a division of Chevron Phillips Chemical Company LLC.
   d. Plastic Fusion Fabricators, Inc.

2. Construction: [Single wall] [Double wall with interstitial space].


4. Connections: Inlets and outlet matching or suitable for piping.

5. Steps: Manufacturer’s standard, fusion welded to sidewall. Omit steps for manholes less than 60 inches deep.

6. Top: Include 24-inch nominal-diameter frame and cover.

2.8 LEAK-DETECTION SYSTEMS

A. Leak-Detection Systems

1. Description: Cable leak-detection system capable of detecting and annunciating fluid leaks; with controls, panel, wiring, cable sensors, probes if required, and piping.

   a. Annunciator Panel: Enclosure with visual and audible alarms and leak location indicator.
   b. Sensors: Electric cable, suitable for insertion into double-containment piping annular space, with capability of detecting fluid leaks and signaling locations of leaks.
2.9 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, plain ends.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.10 SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

   1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel, Plastic or Stainless steel.
   3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements.

2.11 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.
D. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw or spring clips, and chrome-plated finish.

E. One-Piece, Floor-Plate Escutcheons: Cast iron.

F. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

END OF SECTION 226600
5. Fire Protection
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SECTION 210000 - FIRE PROTECTION GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Work under this Section as shown or specified shall be in accordance with the requirements of the Contract Documents.

1.2 DEFINITIONS

A. "Provide": to supply, install and make complete, safe, and operable, the particular work referred to unless specifically indicated otherwise.

B. "Install": to erect, mount, and make complete with all related accessories.

C. "Furnish" or "supply": to purchase, procure, acquire, and deliver complete with related accessories.

D. "Work": labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.

E. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and all related accessories.

F. "Wiring": raceway, fittings, wire, boxes and all related accessories.

G. "Indicated," "shown" or "noted": as indicated, shown, or noted on drawings or specifications.

H. "Similar" or "equal": of base bid manufacturer, equal in quality materials, weight, size, performance, design, and efficiency of specified product, conforming with "Base Bid Manufacturers".

I. "Reviewed" "satisfactory," "accepted", or "directed": as reviewed, satisfactory, accepted, or directed by Architect and/or Engineer.

J. "Motor Controllers": manual or magnetic starters with or without switches, individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

K. "Control or Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, flow operation of equipment.
L. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

M. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

N. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

O. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

P. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

Q. The following are industry abbreviations for plastic materials:

2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

R. The following are industry abbreviations for rubber materials:

1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.3 WORK INCLUDED

A. The work covered by this section includes the construction described in the Contract Documents including all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work includes, but is not limited to the following:
2. Fire Standpipe System and Equipment.
3. Piping, Valves and Fittings.
4. Identification System.
5. Hydraulic Calculations.
7. Hangers, Supports and Guides.
13. Rigging of Equipment.
14. Furnishing access Doors and Frames to be installed under another section.
15. Fire Stopping for Pipe Penetration.
16. Pipe Penetration.
17. Concrete Pads for Equipment.

B. Related Work not Included in this Division but Specified Elsewhere

1. Fire Alarm Wiring.
2. Finish painting, except for pre-finished equipment or as otherwise specified.
3. Concrete work, except equipment inertia and floating bases.
4. Base flashing for piping.
5. Waterproofing.
6. Power wiring for motors and motor controllers.
7. Installation of access doors and frames.

1.4 COORDINATION OF WORK

A. The fire protection drawings show the general arrangement of piping and appurtenances. Follow these drawings as closely as the actual construction will permit. Conform the fire protection work to the requirements shown on the drawings. Provide offsets, fittings, and accessories, which may be required but not shown on the drawings. Investigate the site, structural and finish ground conditions affecting the work, and arrange the work accordingly. Provide such work and accessories as may be required to meet such conditions.

B. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.

C. Carefully check space requirements with other trades to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings.

D. Transmit to other trades all information required for work to be provided under their sections, in ample time for installation.

E. Wherever work interconnects with work of other trades, coordinate with the General Contractor to insure that necessary information is presented so all the necessary connections and equipment may be properly installed. Identify all items (valves, piping, equipment, etc.) in order that the General Contractor will know where to install access doors and panels.

F. Consult with other trades regarding equipment so that, wherever possible, motors, motor controls, pumps and valves are of the same manufacturer.

G. Furnish and set all sleeves for passage of pipes and conduits through structural masonry and concrete walls and floors and elsewhere as will be required for the proper protection of each pipe passing through building surfaces.

H. Provide required supports and hangers for piping and equipment, designed so as not to exceed allowable loadings of structures.

I. Examine and compare the contract drawings and specifications with the drawings and specifications of other disciplines and report any discrepancies between them to the General
Contractor and obtain from him written instructions for changes necessary in the work of this section. Install and coordinate the work of this section in cooperation with the General Contractor installing interrelated work. Before installation, take proper provisions to avoid interferences. All changes required in the work of the contractor, caused by his neglect to do so, are to be made by him at his own expense.

J. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale similar to that of the design drawings, prepared on tracing medium of the same size as contract drawings. With these layouts, coordinate the work with the work of the General Contractor. Such detailed work is to be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion, however, include a set of such drawings with each set of as-built drawings. When directed by the Engineer, submit drawings for review, clearly showing the work of this section and its relation to the work of other disciplines before commencing shop fabrication or erection in the field.

K. Before commencing work, examine all adjoining work on which this work is in any way dependent for perfect workmanship and report any conditions, which prevent performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

L. Provide required anchor bolts, sleeves, inserts and supports. Direct location of anchor bolts, sleeves, inserts and supports to insure that they are properly installed. Any expense resulting from the improper location or installation of anchor bolts, sleeves, inserts and supports to be paid for by the contractor.

M. Slots, chases, openings and recesses through floors, walls, ceilings, and roofs will be provided by the various trades in their respective materials. Properly locate such openings and be responsible for any cutting and patching caused by the neglect to do so.

N. Adjust location of pipes, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each pipe prior to fabrication.

1. Right-of-Way: Lines that pitch have the right-of-way over those that do not pitch, i.e., plumbing drains. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.

2. Make offsets, transitions and changes in direction in pipes as required to maintain proper head room and pitch on sloping lines whether or not indicated on the drawings. Furnish and install all air vents, drains, etc., as required to affect these offsets, transitions and changes in direction.
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March, 2015

O. Install all fire protection work to permit removal (without damage to other parts) of all other parts requiring periodic replacement or maintenance. Arrange pipes and equipment to permit access to valves, cocks, starters, motors, and control components, and to clear the openings of swinging doors and access panels.

P. Provide access panels in equipment as required for inspection and maintenance of internal parts, etc.

Q. This contractor shall coordinate his work with the work of other trades.

R. Coordinated Composite Drawings

1. The Contractor shall prepare full coordinated composite drawings for the mechanical, electrical and fire protection trades. The Contractor shall overlay each trade’s work (in separate colors) on a sepia set of sheetmetal drawings. All conflicts and potential conflicts shall be clearly identified on the sepia sheetmetal drawings. This shall include but not be limited to conflicts with lights, equipment, piping, ductwork and supports of other trades, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trade, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trade attend a weekly job site coordination meeting in the Contractor’s field office. All trades shall resolve conflicts at these meetings and sign off each sepia sheetmetal drawing indicating acceptance and satisfactory resolution to all conflicts. All conflicts that cannot be resolved shall be brought to the attention of the Engineer for resolution.

1.5 USE OF SITE AND LOAD LIMITATIONS

A. The contractor shall review all available data on the location and types of pipelines and other underground utilities. The contractor shall not operate equipment over the facilities and shall take care not to damage them or otherwise impair their use. The contractor shall make investigation to verify the location of these facilities before proceeding with construction and/or operations in their vicinity.

1.6 CONTRACTOR’S RESPONSIBILITY FOR EVALUATION

A. The Engineer and Owner make no representations, regarding the character or extent of the subsoils, water levels, existing structural, mechanical and electrical installations, above or below ground or other subsurface conditions which may be encountered during the Work. The contractor must make his own evaluation of existing conditions, which may affect methods or cost of performing the Work, based on his own examination of the facility or other
information. Failure to examine the drawings or other information shall not relieve the contractor of his responsibility for satisfactory accomplishment of the Work.

B. The locations of existing services are believed to be as indicated on the drawings. The contractor shall verify the actual location of these services and notify the Engineer of any discrepancies prior to commencing work.

1.7 ACCESS TO FIRE PROTECTION EQUIPMENT

A. The contractor shall not interfere with access to hydrants, fire exits, fire hose stations, fire extinguishers, and fire alarm pull stations. In no case shall the contractor’s material or equipment be within twenty-five (25) feet of a hydrant or fire alarm pull station.

1.8 EQUIPMENT AND MATERIALS

A. If products and materials are specified or indicated on the drawings for a specific item or system, the contractor shall use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, in accordance with shop drawings.

B. All products and materials shall be new, clean, free of defects and free of damage and corrosion.

C. No permanent equipment shall be used to provide temporary services during construction.

D. Ship and store all products and materials in a manner which will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair.

E. Make certain that all materials selected directly, or by suppliers, conform to the requirements of the contract drawings and specification. Transmittal of such specifications and drawings, information to persons manufacturing and supplying materials to the project, and rigid adherence thereto, is the contractor’s responsibility. Acceptance of a manufacturer’s name by the Engineer does not release the contractor of the responsibility for providing materials, which comply in all respects with the requirements in the Contract Documents.

F. Applicable equipment and materials to be listed by Underwriters’ Laboratories and Manufactured in accordance with ASME, AWWA, NFPA or ANSI standards, and as approved by the local authorities having jurisdiction.

G. Fully lubricate all equipment when installed and prior to final acceptance.
H. Locate valves, access doors, etc., to be easily accessible, either in mechanical spaces or through access panels specified herein.

I. Follow manufacturers' instructions for installing, connecting, and adjusting all equipment. Provide one copy of such instructions to the Engineer before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Provide all special valves, piping, wiring and accessories.

1.9 QUALITY ASSURANCE

A. Codes Standards and Fees:

1. Codes and Standards:

   a. Comply with all current governing codes, ordinances and regulations, as well as with requirements of NFPA, UL and all other applicable codes.

   b. Comply with the requirements of the State adopted Building Code, NFPA and other agencies or authorities having jurisdiction over any part of the Work and secure all necessary permits.

   c. Where codes or standards are listed herein, the applicable portions apply.

   d. Plans, specifications, codes and standards are all minimum requirements. Where requirements differ, apply the more stringent.

   e. Should any change in plans or specifications be required to comply with governing regulations, the contractor is to notify the Engineer at the time of submitting his bid.

   f. The codes and standards listed in the Specifications can be obtained from the organizations listed as follows:

      1) OSHA   Occupational Safety and Health Act
      2) ANSI    American National Standard Institute, Inc.
      3) ASME    American Society of Mechanical Engineers
      4) ASTM    American Society for Testing and Materials
      5) AWWA    American Water Works Association
6) UL Underwriters Laboratories, Inc.
7) ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
8) NFPA National Fire Protection Association
9) NEMA National Electrical Manufacturers Association
10) AIA American Insurance Association
11) AWS American Welding Society
12) ASA American Standards Association
13) IEEE Institute of Electrical and Electronics Engineers
14) NEC National Electrical Code

g. The particular specification will be identified by appropriate prefix and number only with the latest revision being applicable unless otherwise noted.

2. Fees
   a. Pay all required permit and/or inspection fees.
   b. Pay royalties or fees required in connection with the use of patented devices and systems.

3. Furnish all materials and equipment new, free from defects and with listings or labels of Underwriter's Laboratories, Inc. or other nationally approved testing laboratory.

4. All items of a given type shall be the product of the same manufacturer.

5. All materials and equipment shall be the product of manufacturers regularly engaged in their manufacture.

1.10 PERMITS AND FEES

A. In accordance with General Conditions (AIA Document 201) & Supplementary Conditions for Mechanical & Electrical Work.
B. The Contractor shall give necessary notice, file drawings and specifications with the department having jurisdiction, obtain permits or licenses necessary to carry out this work and pay all fees therefore. The Contractor shall arrange for inspection and test of any or all parts of the work if so required by authorities and pay all charges for same. The Contractor shall pay all costs for, furnish to the Owner before final billing, all certificates necessary as evidence that the work installed conforms with all regulations where they apply to this work.

C. This contractor shall prepare or hire the necessary consultants to prepare and file all plans, calculation, forms, etc. required for filing with all agencies required for this work including but not limited to The DEP (Department of Environmental Protection), DEC (Department of Environmental Conservation, Bureau of Air Resources, EPA Environmental protection Agency, FDNY, etc.).

1.11 SPECIAL / CONTROLLED INSPECTION- NYC

A. Special inspection shall be provided by the owner. This contractor shall provide all required services to accomplish these inspections.

1.12 INSPECTIONS / TESTING

A. Independent testing and inspections shall be provided by this contractor who shall hire the inspector or testing agency

1.13 SHOP DRAWINGS

A. Prepare and submit detailed shop drawings for piping work and other distribution services, including locations and sizes of all openings in floor walls and roofs.

B. The work described in any shop drawing submission to be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job.

C. Each submitted shop drawing to include a certification that all related job conditions have been checked and that no conflict exists.

D. All drawings are to be submitted sufficiently in advance of field requirements to allow ample time for checking. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts to be submitted as a package.

E. If submittals differ from the Contract Document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.
F. Review of any submitted data or shop drawings for material, equipment, apparatus, devices, arrangement and layout shall not relieve the contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details to efficiently perform the requirements and intent of the Work. Such review shall not relieve the contractor from responsibility for errors, omissions or inadequacies of any sort on submitted data or shop drawings.

G. Each shop drawing to contain job title, the names and phone numbers of the General Contractor and the contractor reference to the applicable design drawing or specification article, date and scale.

H. Within 15 days after award of Contract, submit for review, a list of all material and equipment manufacturers whose products are proposed, as well as names of all subcontractors whom the General Contractor proposes to employ.

I. Within three (3) weeks after award of Contract, submit a list of all shop drawings, which will be submitted in the course of the project. List to show disposition of each item, including date of submission, review, and the like. List to be kept up-to-date throughout entire construction period.

J. Submit shop drawings and manufacturer’s data for the following items in accordance with the Contract Documents:

1. Coordinated, detailed shop layout drawings of all mechanical rooms, services and distribution systems, including plans, profiles and sections.

2. Details of piping supports, elbows, anchors and miscellaneous appurtenances.

3. Hangers, supports, inserts, anchors, guides and foundations.

4. Valves.

5. Pressure gauges.

6. Corrosion protective coatings.

7. Equipment and piping layouts at 3/8 in. scale for the building.

8. Location and size of sleeves for openings in floors and walls.

10. Schedule of pipe and fittings, materials and application, valves, escutcheons, air vents, valve tags and schedules, strainers, and water specialties.

11. Pumps and controllers.


14. Sound insulation, thermal insulation and vibration isolation.

15. Motors, motor controllers and wiring diagram.

16. Building automation systems including descriptions, instruments, and alarms.

17. Flashing.

18. Equipment identification and certificates.

19. Sprinkler heads and accessories.

20. Other shop drawings and submittals as requested within the specification.

1.14 SAMPLES

A. Submit samples of all items with exposed finishes for review.

B. Allow sufficient time for consideration without interfering with job schedule.

C. Duplicate quality and finish to type to be supplied under contract.

D. Identify similar to shop drawings.

1.15 ELECTRONIC COPIES OF AKF DRAWINGS

A. If the contractor requires (.dwg) format, after preparation the drawings will be forwarded only upon receipt of signed acceptance of terms form. Permission from the architect must first be obtained for AKF to include the architectural background as reference. The contractor is to obtain the architects latest drawings directly from the architect.

B. These files are being issued for the convenience of the contractor and the contractor remains responsible for all contract requirements related to the normal shop drawing preparation process.
1.16 SUBMISSIONS:

A. Provide all coordination drawings and shop drawings in "AutoCad" format, version compatible with owner. All catalog cuts and submittals to be provided in electronic "PDF" format the architect will forward all submissions to the engineer.

B. If paper submissions are to be provided the following shall be adhered to.

1. Submissions 11 in. X 17 in. or smaller: If the submission is a catalog cut, then the contractor shall submit one original and one copy. Otherwise, they shall submit two copies. The architect will forward the original and one copy (two copies when no original is received) to the engineer. All catalog cuts shall be complete.

2. Submissions larger than 11 in. X 17 in.: submit two copies to the architect. The architect will forward to the engineer.

C. Indicate on each submission: project name and location, architect and engineer, item identification and approval stamp of prime contractor, subcontractor names and phone numbers, reference to the applicable design drawing or specification article, date and scale.

D. The work described in all shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job.

E. Each submitted shop drawing is to include a certification that all related job conditions have been checked and verified and that there are no conflicts.

F. All shop drawings are to be submitted to allow ample time for checking in advance of field requirements. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts shall be submitted as a package.

G. If submittals differ from the contract document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

1.17 AS-BUILTS AND EQUIPMENT OPERATION INSTRUCTIONS

A. Provide all coordination drawings and shop drawings in AutoCad format, version compatible with owner. All catalog cuts and submittals to be provided in electronic "PDF" format the architect will forward all submissions to the engineer.
B. On completion and acceptance of work, this contractor shall furnish written instructions, equipment manuals and demonstrate to the owner the proper operation and maintenance of all equipment and apparatus furnished under this contract.

C. The contractor shall give one copy of the instructions to the owner and one copy to the engineer.

D. Final “as-built” drawings indicating as installed conditions shall be provided to the architect and engineer after completion of the installation.

1.18 START-UP

A. Properly lubricate all pieces of equipment.

B. Check and clean all pipes of dirt and debris.

C. Prepare each piece of equipment in accordance with manufacturer’s installation instructions and have a copy at the equipment.

D. Check rotation on each motor.

E. Have representatives of each manufacturer present when hereinafter specified, so that equipment will be started up by manufacturer.

1.19 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Furnish access doors as required for operation and maintenance of concealed equipment and coordinate their delivery with the installing trade.

B. Coordinate and prepare a location, size and function schedule of access doors required and deliver to the General Contractor and the Architect for review.

C. Doors shall be of a size required for operating and repacking valves, and shall be as manufactured by Karp Associates, Nystrom Inc. or Mifab.

D. Unless otherwise indicated, minimum size to be 18" x 18".

E. Furnish color coded buttons or tabs to indicate location of valves or other equipment located above removable type ceilings where access doors are not required.

1.20 SYSTEMS IDENTIFICATION

A. Piping:
1. All exposed fire protection piping shall be finish painted red in color unless otherwise directed.

2. All piping, exposed or concealed, shall be identified as to its service in accordance with OSHA and ANSI Standards by one of the following methods:
   a. Installation of manufactured adhesive band type identification markers, similar to "Quick-Label" by W.H. Brady Company.

3. Piping identification markings shall be installed as follows:
   a. In each room.
   b. All valve locations.
   c. At shaft walls.
   d. Every 40 feet on continuous runs.

B. Valves:

1. Valves shall be identified by tag system utilizing brass tags at 2-inch minimum diameter and attached to the valves using brass chain.
   a. The new valve tag identification numbers shall be permanently added to all existing valve tag charts.

2. The service and function of all fire protection valves shall be identified at the valve by signs, similar to Potter Roemer Series 6300, attached to the valves by brass chains.

C. Equipment:

1. Identify all controls such as motor starters not in motor control centers, float switches, and alarms.

1.21 OPERATING & MAINTENANCE INSTRUCTION

A. Prepare an operating and maintenance instruction manual which includes the following:

1. Alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
2. Operating instructions for complete system, including:
   a. Normal starting, operating, and shut-down.
   b. Emergency procedures for fire or failure of major equipment.
   c. Summer and winter special procedures.
   d. Day and night special procedures.

3. Maintenance instructions, including:
   a. Valve tag list and equipment tag list.
   b. Proper lubricants and lubricating instructions for each piece of equipment, and date when lubricated.
   c. Required cleaning, replacement and/or adjustment schedule.

4. Manufacturer's data on each piece of equipment, including:
   a. Installation instructions.
   b. Drawings and specifications.
   c. Parts list, including recommended items to be stocked.
   d. Complete wiring and temperature control diagrams.
   e. Marked or revised prints locating all concealed parts and all variations from the original system design.
   f. Test and inspection certificates.

5. Specific equipment data including, but not limited to, the following:
   a. For Fire Protection System:
   b. Pumps.
   c. Piping.
   d. Valves.
e. Accessories.
f. Pressure reducing valves.
g. Sprinkler heads.
h. Tamper switches.
i. Flow switches.
j. Flow measuring devised.
k. Electric wiring.
l. Controllers.

6. For Automatic Control System
   a. Drawings and description of system controlled.
   b. Sequence of operation for each system.
   c. Data on components.
   d. Wiring and piping, schematic any layout, for panels and panelboards.
   e. System operating manual, including set points.

B. Provide instruction of operating personnel.
   1. Instruct Owner’s operating personnel in proper starting sequences, operation, shutdown, and maintenance procedures, including normal and emergency procedures.
   2. Instruction to be by personnel skilled in operation of equipment. Instructions for major equipment to be by equipment manufacturers’ representatives.
   3. Make arrangements to give instructions by system and not by building areas.
   4. Provide five (5) instruction sessions not to exceed six (6) hours each.
   5. Instructions on automatic controls to be by manufacturer’s representative.

C. Submittals.
1. Shop Drawings: Submit three copies for review prior to final issuance.

2. Provide 6 copies of each operation and maintenance manual.
   a. Manuals to be 8-1/2" x 11" size in hard-back, 3-ring loose-leaf binders. Use more than one volume if required. Do not overfill binders.
   b. Manuals to be completed and delivered to the Engineer for approval at least 20 days prior to instruction of operating personnel.

3. Prepare separate manuals for the fire protection systems.

1.22 TOOLS FOR OPERATION, ADJUSTMENT AND MAINTENANCE

A. Deliver to Owner's representative all special tools needed for proper operation, adjustment and maintenance of equipment.

1.23 RECORD DRAWINGS

A. The contractor shall maintain a complete set of “Record Drawings” reflecting an accurate dimensional record of all work. These drawings shall be marked up to show the precise location of concealed work and equipment, including concealed piping and valves and all changes and deviations in the plumbing work from that shown on the contract drawings. This requirement shall not be construed as authorization for the contractor to make changes in the layout or work without written definite instruction from the Architect or Engineer.

B. Record dimensions shall clearly and accurately delineate the work as installed; location shall be suitably identified by at least two dimensions to permanent structures.

C. The contractor shall stamp all “Record Drawings” and certify for correctness by signing and dating them.

D. Record drawings submitted to Owner shall consist of 1 set of mylars and 1 set of compact disk's (CD's) with all work provided on Autocad 2000 format.

E. Prior to final acceptance, contractor shall submit certified “Record Drawings” to the Architect/Engineer for review and make changes, corrections or additions as noted by Architect/Engineer. After this review, the drawing shall be delivered to the Owner.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION
NOT USED.

END OF SECTION
HANGERS AND SUPPORTS
SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.
5. Pipe stands.
6. Pipe positioning systems.
7. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Powder-actuated fastener systems.
   3. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Pipe stands. Include Product Data for components.
   4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel."

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code-Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
B. Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. Masterset Fastening Systems, Inc.
   d. MKT Fastening, LLC.
   e. Powers Fasteners.
B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.5 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:
   a. ERICO/Michigan Hanger Co.
   b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:
   a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:
   a. ERICO/Michigan Hanger Co.
b. MIRO Industries.

c. Portable Pipe Hangers.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:

   a. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.6 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:

   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.
2.8   MISCELLANEOUS MATERIALS

A.   Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B.   Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2.   Design Mix: 5000-psi, 28-day compressive strength

END OF SECTION 210529
HEAT TRACING FOR FIRE-SUPPRESSION PIPING
SECTION 210533 - HEAT TRACING FOR FIRE-SUPPRESSION PIPING

PART 1 - MANUFACTURERS

1.1 SUMMARY
   A. This Section includes heat tracing with the following electric heating cables:
      1. Self-regulating, parallel resistance.

1.2 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 WARRANTY
   A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
      1. Warranty Period: 10 years from date of Substantial Completion.

1.4 FIELD QUALITY CONTROL
   A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
      1. Test cables for electrical continuity and insulation integrity before energizing.
      2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

   B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.
C. Remove and replace malfunctioning units and retest as specified above.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
   2. Raychem; a division of Tyco Thermal Controls.
   3. Thermon Manufacturing Co.

B. Heating Element: Pair of parallel No. 16AWG, nickel-coated stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Cable Cover: [Stainless-steel] braid[, and polyolefin outer jacket with UV inhibitor].

E. Maximum Operating Temperature (Power On): [150 deg F].

F. Maximum Exposure Temperature (Power Off): [185 deg F].

G. Maximum Operating Temperature: [300 deg F].

H. Capacities and Characteristics:
   2. Piping Diameter: Line size
   3. Number of Parallel Cables: As required
   4. Spiral Wrap Pitch: per manufacturer’s recommendations
   5. Volts: [120] [208] [240] [277] [480] <Insert value> V.
   6. Phase: <Insert value.>
2.2 CONTROLS
   A. Remote bulb unit with adjustable temperature range from [30 to 50 deg F].
   B. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES
   A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
   B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
      2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

END OF SECTION 210533
VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Restraining braces.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: A B C D E F.
   2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I II III.
      a. Component Importance Factor: 1.0 1.5
      b. Component Response Modification Factor: 1.5 2.5 3.5 5.0
      c. Component Amplification Factor: 1.0 2.5
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): <Insert percent>.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability
   to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as
   defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having
   jurisdiction.

B. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in
   this Section are more stringent.
C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
4. Isolation Technology, Inc.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.

B. Pads <Insert drawing designation>: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene rubber hermetically sealed compressed fiberglass.

C. Mounts <Insert drawing designation>: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts <Insert drawing designation>: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four <Insert number> times the maximum seismic forces to which they will be subjected.
C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections Reinforcing steel angle clamped to hanger rod.

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

I. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer’s standard prime-coat finish ready for field painting.

B. Finish: Manufacturer’s standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

END OF SECTION 210548
WATER-BASED FIRE-SUPPRESSION SYSTEMS
PART 1 - GENERAL

A. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

1. Minimum Density for Automatic-Sprinkler Piping Design: According to NFPA 13, unless otherwise indicated:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
   d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
   e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
   f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

2. Where listed quick-response sprinklers are used throughout a system or portion of a system having the same hydraulic design basis, the system area of operation shall be permitted to be reduced without revising the density as permitted by NFPA 13 (as revised by Appendix Q):

3. Maximum Protection Area per Sprinkler:
   a. Office Spaces: 225 sq. ft.
   b. Storage Areas: 130 sq. ft.
   c. Mechanical Equipment Rooms: 130 sq. ft
   d. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
   c. Extra-Hazard Occupancies: 500 gpm) for 90 to 120 minutes.

B. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and NYC IBC 2008
1.2 PERFORMANCE REQUIREMENTS


B. High-Pressure Piping System Component Working Pressure: Listed for 300 psig.

C. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.
   1. Minimum residual pressure at each hose-connection outlet is the following:
      a. NPS 1-1/2 Hose Connections: 65 psig.
      b. NPS 2-1/2 Hose Connections: 65 psig

D. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
   1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

1.3 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer’s responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
   3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 with factory- or field-formed threaded ends.

5. Steel Threaded Couplings: ASTM A 865


2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, roll]-grooved ends.

1. Grooved Joint Piping Systems:
   a. Manufacturers:
      
      1) Gruvlok Anvil International
      2) Victaulic Co. of America.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 300-psig pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.

2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.

3. Manufacturers:
   a. Kennedy Valve Div.
   b. NIBCO.
   c. Stockham.
   d. Victaulic

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.

2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.

3. NPS 3 Ductile-iron body with grooved ends.

4. Manufacturers:
   a. NIBCO.
   b. Stockham
   c. Victaulic

5. TycoNPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
a. Manufacturers:
1) Stockham/Victaulic.
2) NIBCO.
3) Tyco

D. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:
   a. Victaulic/ Crane Co/Tyco
   b. Mueller Company.
   c. NIBCO.
   d. Stockham.

E. Gate Valves: UL 262,

1. NPS 2 and Smaller: Bronze body with threaded ends.
   a. Manufacturers:
      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) Nibco.
      3) Stockham

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends. OS&Y type.
   a. Manufacturers:
      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) Mueller Company.
      3) NIBCO.
      4) Stockham

F. Iron Butterfly Valves:

a. Grinnel.
b. NIBCO INC.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.

2. Standard: UL 1091.
4. Body Material: Cast or ductile iron.
5. Style: Lug or wafer.

2.4 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 300-psig pressure rating if valves are components of high-pressure piping system.

1. Manufacturers:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Victaulic Co. of America.

2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages,[ retarding chamber,] and fill-line attachment with strainer.
   a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

3. Dry-Pipe Valves: UL 260, differential type; with bronze seat with O-ring seals, single-hinge pin, and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
   a. Air-Pressure Maintenance Device: UL 260, automatic device to maintain correct air pressure in piping. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig adjustable range, and 175-psig maximum inlet pressure.

1) Manufacturers:
   a) Reliable Automatic Sprinkler Co., Inc.
   b) Viking Corp.
   c) Tyco
b. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.

1) Manufacturers:
   a) Gast Manufacturing, Inc.
   b) Reliable Automatic Sprinkler Co., Inc.
   c) Viking Corp.

4. Deluge Valves: UL 260, cast-iron body, hydraulically operated, differential-pressure type. Include bronze seat with O-ring seals, trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.

   a. Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.
   b. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.

B. Pressure-Regulating Valves: UL 1468, brass or bronze, NPS 1-1/2 and NPS 2-1/2, 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.

1. Finish: Rough metal.
2. Manufacturers:
   b. Fire-End and Croker Corp.
   c. Grinnell Fire Protection.
   d. Potter-Roemer; Fire Protection Div.
   e. Zum Industries, Inc.; Wilkins Div.
   f. Claval

C. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
1. Manufacturers:
   a. AFAC Inc.
   b. Grinnell Fire Protection.

2.5 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

E. Pressure-Regulating Valves: UL 1468, brass or bronze, NPS 1-1/2 and NPS 2-1/2, 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.

   1. Finish: Rough metal.
   2. Manufacturers:
      b. Fire-End and Croker Corp.
      c. Grinnell Fire Protection.
      d. Potter-Roemer; Fire Protection Div.
      e. Zurn Industries, Inc.; Wilkins Div.

2.6 MANUAL CONTROL STATIONS

A. Manual Control Stations: UL listed or FMG approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
2.7 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: UL listed and FMG approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.

2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and a cover held closed by breakable strut.

2.8 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 300-psig pressure rating if sprinklers are components of high-pressure piping system.

B. Manufacturers:
   1. Reliable Automatic Sprinkler Co., Inc.

C. Automatic Sprinklers: With heat-responsive element complying with the following:

   1. UL 199, for nonresidential applications.
   2. UL 1626, for residential applications.
   3. UL 1767, for early-suppression, fast-response applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.


      a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
      b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.

E. Sprinkler types, features, and options as follows:
1. Concealed ceiling sprinklers, including cover plate.
2. Extended-coverage sprinklers.
3. Flush ceiling sprinklers, including escutcheon.
4. Open sprinklers.
5. Pendent sprinklers.
6. Pendent, dry-type sprinklers.
7. Quick-response sprinklers.
8. Recessed sprinklers, including escutcheon.
10. Sidewall, dry-type sprinklers.
11. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, 2 piece, with 1-inch vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.9 HOSE CONNECTIONS

A. Manufacturers:

2. Fire-End and Croker Corp.
3. Potter-Roemer; Fire-Protection Div.

B. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include NPS 1-1/2 or NPS 2-1/2 as indicated, and hose valve threads according to NFPA 1963 and matching local fire department threads.

1. Valve Operation: Nonadjustable type, unless pressure-regulating type is indicated.
2. Finish: Rough metal.
2.10 HOSE STATIONS

A. Manufacturers:

2. Fire-End and Croker Corp.
3. Potter-Roemer; Fire-Protection Div.

B. Description: UL 47, semiautomatic hose stations. Include brass rack nipple, hose rack, and the following:

1. Valve: UL 668, brass or bronze, 300-psig minimum pressure rating, 90-degree-angle-pattern hose valve with female NPS inlet and outlet, unless otherwise indicated.
   a. Valve Operation: Nonadjustable type, unless pressure-regulating type is indicated.

4. Fire Hose: NFPA 1961 and UL 219, lined fire hose with couplings, gaskets, and nozzle. Include the following fire hose materials:
   b. Lining: Rubber compound.
   c. Cover: Rubber

7. Mountings: Pipe escutcheon for cabinet-mounted units.

C. NPS 2-1/2 by NPS 1-1/2 Hose Station: NPS 2-1/2 hose valve; NPS 2-1/2 by NPS 1-1/2 reducer adapter; hose rack with water-retention device and pins for folded, NPS 1-1/2 lined hose; NPS 1-1/2 lined hose with swivel inlet coupling and nozzle; and reducer-adapter spanner wrench.

2. Hose Valve and Trim Finish: Rough metal.
3. Fire Hose: Lined, 125-foot NYC length.
4. Nozzle: Polycarbonate plastic, adjustable from shutoff to fog spray or straight stream.
2.11 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:

2. Fire-End and Croker Corp.
3. Potter-Roemer; Fire-Protection Div.
4. Reliable Automatic Sprinkler Co., Inc.

B. Wall-Type, Fire Department Connection: UL 405, 300-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

1. Type: Flush, with two inlets and square or rectangular escutcheon plate.
2. Type: Exposed, projecting, with two inlets and round escutcheon plate.
3. Finish: Polished chrome-plated

2.12 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch-diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.

1. Manufacturers:
   a. 
   b. Reliable Automatic Sprinkler Co., Inc.

C. Electrically Operated Alarm: UL 464, with 6-inch minimum-diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.

1. Manufacturers:
b. System Sensor.

D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:
   b. Potter Electric Signal Company.
   c. System Sensor.
   d. Viking Corp.

E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Manufacturers:
   b. Potter Electric Signal Company.
   c. System Sensor.
   d. Viking Corp.

F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:
   a. Kennedy Valve Div.
   b. Potter Electric Signal Company.
   c. System Sensor.

2.13 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge.
3. Marsh Bellofram.

B. Description: UL 393, 3-1/2- to 4-1/2-inch-diameter, dial pressure gage with range of 0 to 300 psig.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

2.14 STANDPIPE SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Type Standpipe System, 175-psig Maximum Working Pressure:

1. Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.

2.15 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:

1. NPS 1-1/2 and Smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
2. NPS 2: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
3. NPS 2-1/2 to NPS 6 Grooved-end, black, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

END OF SECTION 211000
CLEAN-AGENT FIRE EXTINGUISHING SYSTEM
SECTION 212200 - CLEAN-AGENT FIRE EXTINGUISHING SYSTEM

PART 1 - PRODUCTS

1.1 SUMMARY

A. This Section includes clean-agent extinguishing systems and the following:
   1. Piping and piping specialties.
   2. Extinguishing-agent containers.
   3. Extinguishing agent.
   5. Control and alarm panels.
   6. Accessories.
   7. Connection devices for and wiring between system components.
   8. Connection devices for power and integration into building’s fire alarm system.

1.2 SYSTEM DESCRIPTION

A. Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity below the ceiling and below the raised floor. Provide separate zones above and below the raised floor. If smoke is detected below the raised floor, agent shall be discharged in the underfloor zone only. If smoke is detected above the raised floor, agent shall be discharged in zones above and below the floor.

1.3 PERFORMANCE REQUIREMENTS

A. Design clean-agent extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, or C fires as appropriate for areas being protected and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Extinguishing-agent containers.
2. Extinguishing agent.
3. Discharge nozzles.
4. Control panels.
5. Detection devices.
7. Switches.
8. Alarm devices.
9. Pipe hangers and supports, including seismic restraints.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include design calculations. Include the following for hazard-area enclosure, drawn to scale:

1. Plans, elevations, sections, details, and attachments to other work. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Design Calculations: For weight, volume, and concentration of extinguishing agent required for each hazard area.
4. Reflected Ceiling Plans: Show ceiling penetrations, ceiling-mounted items, and the following:
   a. Extinguishing-agent containers, piping, discharge nozzles, detectors, and accessories.
   b. Method of attaching hangers to building structure.
   c. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.

5. Occupied Work Area Plans: Show the following:
   a. Controls and alarms.
   b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
   c. Equipment and furnishings.

6. Access Floor Space Plans: Show the following:
   a. Extinguishing-agent containers, piping, discharge nozzles, detectors, and accessories.
   b. Method of supporting piping.

C. Permit Approved Drawings: Working plans, prepared according to NFPA 2001, that have been approved by authorities having jurisdiction. Include design calculations.
D. Field quality-control test reports.

E. Maintenance Data: For components to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of clean-agent extinguishing systems that are similar to those indicated for this Project in material, design, and extent.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of clean-agent extinguishing systems and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles were titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

Manufacturers:
2. Fike Corporation.
4. Fenwall

2.2 PIPING MATERIALS

A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.
2.3 PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106, Grade B; Schedule 40, or Schedule 80, seamless steel pipe.

1. Threaded Fittings:
   b. Flanges and Flanged Fittings: ASME B16.5, Class 300, unless Class 600 is indicated.

2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
3. Grooved-End Fittings: FMG approved and NRTL listed, ASTM A47/A47M malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

B. Plain-End, Hard Copper Tube: ASTM B88, Type K or L, water tube, drawn temper.


C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, unless thickness or specific material is indicated.

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for halon or clean-agent service, and matching steel-pipe dimensions. Include ASTM A536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.4 VALVES

A. General: Brass; suitable for intended operation.
B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.5 EXTINGUISHING-AGENT CONTAINERS

A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

1. Finish: Red enamel or epoxy paint.
2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
3. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
4. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

2.6 FIRE-EXTINGUISHING CLEAN AGENT

A. Clean Agent: HFC 227ea, heptafluoropropane.

B. Novec 1230

 Manufacturers:
 a. Chemetron Fire Systems.
b. Fike Corporation.
c. Kidde-Fenwal, Inc.
d. Fenwall

2.7 DISCHARGE NOZZLES

A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, discharge pattern, and capacity required for application.
2.8 MANIFOLD AND ORIFICE UNIONS

A. Description: NRTL-listed device with minimum 2175-psig pressure rating, to control flow and reduce pressure of IG-541 gas in piping.
   1. NPS 2 and Smaller: Piping assembly with orifice, sized for system design requirements.
   2. NPS 2-1/2 and Larger: Piping assembly with nipple, sized for system design requirements.

2.9 CONTROL PANELS

A. Description: FMG approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.

B. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
   1. Mounting: [Recessed flush with surface] [Surface].

D. Supervised Circuits: Separate circuits for each independent hazard area.
   1. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
   3. Alarm circuit.
   5. Abort circuit.
   6. EPO circuit.

E. Provide the following control-panel features:
   1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
   2. Automatic switchover to standby power at loss of primary power.
   3. Storage container, low-pressure indicator.
   4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.
F. Annunciator Panel: Graphic type showing protected, hazard-area plans and locations of detectors, abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.

G. Standby Power: Lead-acid or nickel-cadmium batteries with capacity to operate system for 72 hours and alarm for minimum of 15 minutes. Include automatic battery charger, with varying charging rate between trickle and high depending on battery voltage, that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, and suitable enclosure.

2.10 DETECTION DEVICES

A. Description: Comply with NFPA 2001 and NFPA 72, and include the following types:

1. Ionization Detectors: Comply with UL 268, dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
2. Photoelectric Detectors: Comply with UL 268, consisting of LED light source and silicon photodiode receiving element.
3. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.
   a. Comply with UL 268 and NRTL listed, operating at 24-V dc, nominal.
   b. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
   c. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
   d. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg at all sampling ports.
   e. Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
   f. Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite “trouble” signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

2.11 MANUAL STATIONS

A. General Description: Surface FMG approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

C. Abort Switch: "ABORT" caption, momentary contact, with green finish.

D. EPO Switch: "EPO" caption, with yellow finish.

2.12 SWITCHES

A. Description: FMG approved or NRTL listed, where available, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.

   1. Low-Agent Pressure Switches: Pneumatic operation.
   2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
   3. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.13 ALARM DEVICES

A. Description: FMG approved or NRTL listed, low voltage, and surface mounting, unless otherwise indicated.

B. Bells: Minimum 6-inch diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

2.14 ELECTRICAL POWER AND WIRING

Electrical power, wiring, and devices are specified in Division 26.

2.15 FIELD QUALITY CONTROL

A. Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following tests and inspections to demonstrate compliance with requirements:

   1. Check mechanical items.
2. Inspect extinguishing-agent containers and extinguishing agent, and check mountings for adequate anchoring to substrate.
3. Check electrical systems.
5. Perform functional pre-discharge test.
7. Check remote monitoring operations.
8. Check control-panel primary power source.
9. Perform "puff" test on piping system, using nitrogen.

B. Perform field-acceptance tests of each clean-agent extinguishing system when installation is complete. Perform system testing only after hazard-area enclosure construction has been completed and openings sealed. Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following to demonstrate compliance with requirements:

1. Perform functional predischarge test.
2. Perform system functional operational test.
3. Check remote monitoring operations.
4. Check control-panel primary power source.
5. Perform "puff" test on piping system, using nitrogen.

C. Correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be corrected or does not perform as specified and indicated, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

1. Report test results promptly and in writing to Architect and authorities having jurisdiction.

D. Perform the following field tests and inspections and prepare test reports:

1. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 212200
ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS
SECTION 213113 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes electric-drive, split-case centrifugal fire pumps and the following:

1. Full, Special-service fire-pump controllers and automatic transfer switches.
2. Fire-pump accessories and specialties.
3. Pressure-maintenance pumps, controllers, accessories, and specialties.
4. Alarm panels.
5. Flowmeter systems.

1.2 PERFORMANCE REQUIREMENTS

A. Pump, Equipment, Accessory, Specialty, and Piping Pressure Rating: 175-psig minimum working-pressure rating, unless otherwise indicated.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain fire pumps, pressure-maintenance pumps, and controllers through one source from a single manufacturer for each type of equipment.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of fire pumps, pressure-maintenance pumps, and controllers and are based on specific systems indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Aurora Pump; Pentair Pump Group.
   b. Patterson Pump Company.

2.2 CENTRIFUGAL FIRE PUMPS

A. Description, General: UL 448, factory-assembled and -tested, electric-drive, centrifugal fire pumps capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head and with shutoff head limited to 140 percent of total rated head.

1. Finish: Manufacturer’s standard red paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacities, characteristics, and other pertinent data.

B. Fabricate base and attachment to fire pumps, pressure-maintenance pumps, and controllers with reinforcement to resist movement of pumps and controllers during a seismic event when their bases are anchored to building structure.

C. Multistage, Horizontally Mounted, Split-Case Fire Pumps: Two-stage, single-suction type with pump and driver mounted on same base and connected with coupling.

1. Pump: Axially split cast-iron casing with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.
   a. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
   b. Wear Rings: Replaceable, bronze.
   c. Shaft and Sleeve: Steel shaft with bronze sleeve.

1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

3. Driver: UL-listed, NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.
   a. Manufacturers:
      1) Emerson; U.S. Electrical Motors.
      2) Lincoln Electric Company (The).
      3) Marathon Electric, Inc.

D. In-Line Fire Pumps: Vertically mounted type with electric-motor driver directly mounted to pump casing.

1. Manufacturers:
   a. Aurora Pump; Pentair Pump Group.
   b. Patterson Pump Company.

2. Pump: Radially split cast-iron casing with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless otherwise indicated.
   a. Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.
   b. Wear Rings: Replaceable, bronze.
   c. Shaft and Sleeve: Steel shaft with bronze sleeve.
      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

3. Driver: UL-listed, NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.
   a. Manufacturers:
      1) Emerson; U.S. Electrical Motors.
      2) Lincoln Electric Company (The).
      3) Marathon Electric, Inc.
FIRE-PUMP CONTROLLERS

A. Fire-Pump Controllers, General: UL 218 and NFPA 20; listed for electric-drive, fire-pump service and service entrance; combined automatic and manual operation; factory assembled and wired; and factory tested for capacities and electrical characteristics.

1. Manufacturers:
   b. Firetrol, Inc.
   c. Joslyn Clark.
   d. Master Control Systems, Inc.
   e. Metron, Inc.

2. Rate controllers for scheduled fire-pump horsepower and short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.

3. Enclosure: UL 50, Type 2, dripproof, indoor, unless special-purpose enclosure is indicated. Include manufacturer’s standard red paint applied to factory-assembled and tested unit before shipping.

4. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed.
   a. Isolating means and circuit breaker.
   b. “Power on” pilot lamp.
   c. Fire-alarm system connections for indicating motor running condition, loss-of-line power, and line-power phase reversal.
   d. Automatic and manual operation, and minimum run-time relay to prevent short cycling.
   e. Water-pressure-actuated switch with independent high and low calibrated adjustments responsive to water pressure in fire-suppression piping.
   f. Automatic and manual shutdown.
   g. System pressure recorder, electric ac driven with spring backup.

5. Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.

6. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, NPS 1/2, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 3/32-inch orifice in clapper or ground-face union with noncorrosive diaphragm having 3/32-inch orifice.
B. Full-Service Fire-Pump Controllers:

1. Type Starting: [Across the line] [Wye delta, closed transition] [Wye delta, open transition] [Autotransformer, closed transition] [Solid state, closed transition].
3. Automatic Transfer Switches: UL 218 and UL 1008 and requirements for and attached to fire-pump controllers. Include enclosure complying with UL 50, Type 2, with automatic transfer switch with rating at least equal to fire-pump driver-motor horsepower. Include ampere rating not less than 115 percent of motor full-load current and suitable for switching motor-locked rotor current.

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:

2. Circulation relief valve.
3. Suction and discharge pressure gages.
4. Eccentric-tapered reducer at suction inlet.
5. Concentric-tapered reducer at discharge outlet.
6. Test-Header Manifold: Ductile-iron or brass body for hose valves. Include nozzle outlets arranged in single line; horizontal, flush-wall mounting attachment; and rectangular, roughbrass finish escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
7. Test-Header Manifold: Ferrous body for hose valves. Manufacturer's standard finish. Include bronze or cast-iron, exposed-type valve header with nozzle outlets; and round, brass escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
8. Hose Valves: UL 668, straightway pattern, and bronze with cap and chain. Include NFPA 1963 hose thread that complies with local fire department standards and finish same as for test-header-manifold escutcheon plate.
10. Main Relief Valve: UL 1478, spring loaded.
11. Discharge Cone: Open type.
12. Finish: Manufacturer's standard factory-applied red paint unless brass or other finish is specified.
2.5 PRESSURE-MAINTENANCE PUMPS

A. Pressure-Maintenance Pumps, General: Factory-assembled and -tested pumps with electric-motor driver, controller, and accessories and specialties. Include cast-iron or stainless-steel casing and bronze or stainless-steel impellers, mechanical seals, and suction and discharge flanges machined to ASME B16.1, Class 125 dimensions unless Class 250 flanges are indicated and except that connections may be threaded in sizes where flanges are not available.

1. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacity, characteristics, and other pertinent data.

B. Multistage, Pressure-Maintenance Pumps: Multiple-impeller type complying with HI 1.1-1.2 and HI 1.3 requirements for multistage centrifugal pumps. Include base.

1. Manufacturers:
   a. Grundfos Pumps Corp.
   b. Sterling Peerless Pump; Sterling Fluid Systems Group.
   c. AC Pump; ITT Industries

2. Driver: NEMA MG 1, open-dripproof, squirrel-cage, induction motor complying with NFPA 20 and NFPA 70. Include wiring compatible with controller used.

C. Controllers: UL 508; factory-assembled, -wired, and -tested, across-the-line type for combined automatic and manual operation.

1. Manufacturers:
   b. Firetrol, Inc.
   c. Joslyn Clark.
   d. Master Control Systems, Inc.
   e. Metron, Inc.

2. Enclosure: UL 508 and NEMA 250, Type 2, wall-mounting type for field electrical wiring.
   a. Finish: Manufacturer's standard color paint applied to factory-assembled and -tested unit before shipping.
3. Rate controller for scheduled horsepower and include the following:
   a. Fusible disconnect switch.
   b. Pressure switch.
   c. Hand-off-auto selector switch.
   d. Pilot light.
   e. Running period timer.

D. Accessories and Specialties: Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:

2. Suction and discharge pressure gages.

2.6 FLOWMETER SYSTEMS

A. Description: Fire-pump flowmeter system that indicates flow to not less than 175 percent of fire-pump rated capacity. Include sensor of size to match pipe, tubing, flowmeter, and fittings.

1. FMG-Approved Manufacturers:
   a. Dieterich Standard Inc.
   b. Hyspan Precision Products, Inc.
   c. Meriam Instruments Div.; Scott Fetzer Co.
   d. Preso Meters Corporation.

3. Sensor: Venturi, annubar probe, or orifice plate, unless otherwise indicated.
4. Flowmeter: Compatible with flow sensor with dial not less than 4-1/2 inches in diameter or manufacturer's equivalent size.
5. Permanently Mounted Flowmeter: Suitable for wall mounting with copper tubing to connect to flow sensor.

2.7 PRESSURE GAGES

A. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter dial with range of 0- to 300-psig minimum. Include caption "WATER" on dial face.
1. Manufacturers:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Dresser Equipment Group; Instruments Div.
   c. Marsh Bellofram.
   d. WIKA Instrument Corporation.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.

B. Verification of Performance: Rate fire pumps according to requirements indicated.

2.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire pump performs as indicated.

C. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
   a. Lubricate oil-lubrication-type bearings.
   b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer’s written instructions.
   c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.

3. Starting procedure for pumps is as follows:
   a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
   b. Open sealing-liquid supply valves if pump is so fitted.
   c. Start motor.
   d. Open discharge valve slowly.
   e. Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.
   f. Check general mechanical operation of pump and motor.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are for field-acceptance tests only and are not property of Owner.

END OF SECTION 213113
6. Commissioning
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COMMISSIONING SUBMITTAL INSERT
1.5 SUBMITTAL REQUIREMENTS FOR COMMISSIONING

A. Normal Submittals:
   1. Submit copy of normal submittals for equipment to be commissioned to Commissioning Authority (CxA).
   2. CxA will review normal submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with Architect's and Construction Manager's review.
   3. Provide copy of the Design Team's review comments to the CxA.
   4. Repeat this process for any resubmissions.

B. Data for Commissioning:
   The following information shall be included in all submittals of commissioned equipment and systems.
   1. Detailed manufacturer's installation and start-up procedures.
   2. Operating, troubleshooting, and maintenance procedures.
   3. Fan and pump curves.
   4. Full warranty information, with responsibilities of Owner to keep warranty in force clearly defined.
   5. Installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms to be used by factory or field technicians.

C. CxA will request specific information needed about each piece of commissioned equipment or system. Information requested includes, but is not limited to:
   1. Full details of Owner-contracted tests, if any.
   2. Full factory testing reports, if any.

D. CxA may request additional documentation necessary for commissioning process. Requests by CxA may precede, be concurrent with, or follow normal submittals.

E. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by CxA's review.
OPERATION AND MAINTENANCE
SECTION 017823 – OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing both paper and electronic versions of operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Operation manuals for systems, subsystems, and equipment.
3. Maintenance manuals for the care and maintenance of products, materials, and finishes, systems and equipment.

B. Related Sections include the following:

1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
3. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
4. Division 01 Section "Commissioning General Requirements"
5. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

A. Initial Submittal: Submit 1 draft paper copy and 3 draft electronic copies of each manual to Construction Manager, Architect and CxA at least 90 days before requesting inspection for Substantial Completion. Include complete operation and maintenance directory.
Construction Manager and Architect, through Construction Manager will return 1 copy of draft and mark whether general scope and content of manual are acceptable.

B. Final Submittal: Submit 1 paper copy and 3 electronic copies of each manual in final form to Construction Manager, Architect, and Commissioning Agent at least 15 days before final inspection. Construction Manager, Architect, and Commissioning Agent, through Construction Manager will return copy with comments within 15 days after final inspection.

1. Correct or modify each manual to comply with comments. Submit 3 paper copies and 6 electronic copies of each corrected manual within 15 days of receipt of comments.

C. In preparation of operation and maintenance data, use personnel thoroughly trained and experienced in operation and maintenance of equipment or system involved.

1. Where manuals require written instructions, use personnel skilled in technical writing where necessary for communication of essential data.

   a. Where maintenance manuals require drawings or diagrams, use draftspersons capable of preparing drawings clearly in understandable format.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name, address, and telephone number of Contractor.
6. Name and address of Architect.
7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Paper Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

   a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

   b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL." Project title or name, and subject matter of contents including section number of section or sections, as applicable. Include
volume number for multiple volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

3. Where computerized electronic equipment requires diagnostic software diskettes, provide protective transparent protective sleeve of same overall size as binder contents. Punch and bind sleeve in appropriate manual.


5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
   c. Provide specially prepared drawings where necessary to supplement manufacturer's printed data to illustrate relationship of component parts of equipment or systems or to provide control or flow diagrams. Coordinate specially prepared drawings with information contained in project record drawings specified in Division 01 Section “Project Record Documents” to assure correct illustration of completed installation. Do not use original record documents as part of operation maintenance manuals.

6. Specifications: Component or system specification section copied and inserted complete with modifications.

E. Electronic Manual Contents: Electronic manuals shall be organized consistent with the paper manuals as described in the previous section. The manuals shall be in a single, searchable format with virtual “notebooks” corresponding to each paper notebook. If any materials are converted from an original format (MS Word, Excel, Powerpoint, and Access; AutoCAD or REVIT) for this manual, the original format versions shall be included on Appendix CD/DVDs.

1. The manuals shall be provided in Adobe PDF format. Individual sections shall be “bookmarked” for easy identification.

2. Source materials shall be in Microsoft Word, Excel, or Access and shall be included in Appendix CD/DVDs.

3. All drawings shall be included as PDF files and AutoCAD files.

4. If projects are developed in BIM, the original REVIT file shall be provided in an appendix.
2.4 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer’s name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed. Provide a recommended schedule for calibrating sensors and actuators.

E. Systems: Diagram pipe (both plumbing, and HVAC) ductwork and electrical distribution as installed, and identify color-coding where required for identification.

F. Condensed Operating Instructions: Condensed instructions for start-up, shut-down, emergency operation, safety precautions, unusual features, and troubleshooting instructions.

1. In addition to copy in Operation and Maintenance Manual, permanently secure
2.5 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual’s table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:
   1. Product name and model number.
   2. Manufacturer’s name.
   3. Color, pattern, and texture.
   5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer’s written recommendations and the following:
   1. Inspection procedures.
   2. Types of cleaning agents to be used and methods of cleaning.
   3. List of cleaning agents and methods of cleaning detrimental to product.
   4. Schedule for routine cleaning and maintenance.
   5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers’ maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in the manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in
C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
   a. If system’s control drawing is not adequate, provide simplified, professionally drawn, single line diagrams on minimum 8-1/2 by 11 inch (215 by 280 mm) (A4 size), 20 pound (75 g) white bond paper.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training videotape, if required.
7. List of special tools required to service or maintain equipment.

E. Preventive Maintenance Instructions: Condensed typewritten excerpts from manufacturer’s written instructions for weekly, monthly, quarterly, annual, and other regularly scheduled maintenance prepared by mechanical subcontractor with assistance from equipment supplier. Provide this maintenance information in a MS Excel spreadsheet. Coordinate the individual columns and layout of the spreadsheet with the Commissioning Agent and NYP to ensure the information can be imported into the computerized Maintenance Management System (CMMS).

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Provide this maintenance information in a MS Excel spreadsheet. Coordinate the individual columns and layout of the spreadsheet with the Commissioning Agent and NYP to ensure the information can be imported into the computerized Maintenance Management System (CMMS).
G. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

H. Control Drawings: Include control drawings for equipment and components, including sequence of operation. Control drawings shall be prepared by controls contractor and included here and in control contractor's Operation and Maintenance Manual submittal.

I. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

J. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

K. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.

2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
1. Do not use original Project Record Documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."

E. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823
DEMONSTRATION AND TRAINING
SECTION 017900 – DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for instructing Owner’s personnel, including the following:
   1. Demonstration of operation of systems, subsystems, and equipment.
   2. Training in operation and maintenance of systems, subsystems, and equipment.
   3. Demonstration and training videotapes.

B. Related Sections include the following:
   1. Division 01 Section "Project Management and Coordination" for requirements for Pre-Instruction Conferences.
   2. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.
   3. Division 01 Sections 019113 – Commissioning General Requirements

1.3 SUBMITTALS

A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors’ names for each training module. Include learning objective and outline for each training module.
   1. At completion of training, submit one complete training manual(s) for Owner’s use.

B. Qualification Data: For facilitator.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

E. Demonstration and Training Videotapes: Submit two copies within seven days of end of each training module.
1. Identification: On each copy, provide an applied label with the following information:
   a. Name of Project.
   b. Name and address of photographer.
   c. Name of Architect and Construction Manager.
   d. Name of Contractor.
   e. Date videotape was recorded.
   f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

2. Transcript: Prepared on 8-1/2-by-11-inch (215-by-280-mm) paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Pre-Instruction Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
   1. Inspect and discuss locations and other facilities required for instruction.
   2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
   3. Review required content of instruction.
   4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:

1. Fire alarm systems
2. Fire suppression systems
3. Electronic security systems.
4. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, and water distribution piping.
5. Refrigeration systems, including chillers, cooling towers, condensers, pumps, all distribution piping.
6. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
7. HVAC instrumentation and controls.
8. Electrical service and distribution, including transformers, switchboards, panel boards, uninterruptible power supplies, and motor controls.
9. Lighting equipment and controls.
10. Communication systems, including intercommunication, surveillance, clocks and programming, voice and data, and television equipment.
11. Plumbing systems and equipment, including hot water heaters, well pumps and systems, booster pumps, treatment systems, and rainwater harvesting systems
12. Medical and lab systems, including medical air, medical gases, medical vacuum, lab air, lab gas, lab vacuum, and RO/DI water systems.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.
2. Documentation: Review the following items in detail:
   a. Emergency manuals.
   b. Operations manuals.
   c. Maintenance manuals.
   d. Project Record Documents.
   e. Identification systems.
   f. Warranties and bonds.
   g. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Special operating instructions and procedures.

5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
3.1  PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

3.2  INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Provide manufacturer’s instructors or instructors certified by manufacturer as being experienced in operation and maintenance procedures for each system, subsystem, or piece of equipment to instruct Owner’s personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner’s operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Provide three (3) sessions for each training module. One on first shift, one on second shift, and one on third shift to accommodate all of the hospital personnel.
2. Schedule training with Owner through Construction Manager and CxA with at least fourteen (14) days’ advance notice.
3. Schedule training to conform to personnel availability at Site and to conclude prior to

PART 3 - EXECUTION

9. Energy and Environment

a. Energy impact.
b. Optimization of energy utilization.
c. Environmental impact.
d. Ongoing strategies revised to maintain performance.
start up of system.

D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral and/or a demonstration performance-based test.

E. In addition to written technical descriptions, training shall detail training program to allow those who have completed training to provide training for new employees resulting in self-perpetuating training program.

F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEOTAPES

A. General: Engage a qualified commercial photographer to record demonstration and training videos. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Format: Provide high-quality video on DVD.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on videotape by audio narration by microphone while video is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.

E. As part of training, devote 1 lesson plan to reviewing of video to allow new employees to view tape at their own convenience and be able to comprehend system without need for instructor in attendance.

END OF SECTION 017900
COMMISSIONING OF GENERAL REQUIREMENTS
SECTION 019113 - COMMISSIONING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objectives and criteria. The Commissioning process begins at project inception (during the pre-design phase) and continues through the life of the facility. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the owner’s project requirements.

B. The Goals of the Commissioning Process are to:
   1. Verify that applicable equipment and systems are installed according to the contract documents, manufacturer’s recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
   2. Verify and document proper performance of equipment and systems.
   3. Verify that O&M documentation left on site is complete.
   4. Verify that the owner’s operating personnel are adequately trained.

C. In addition to the scope of work described above, the Cx process will include all work required to satisfy the LEED project requirements. Specifically EA Prerequisite 1, Fundamental Building Systems Commissioning and EA Credit 3, Enhanced Commissioning will be provided.

D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions, Division 01, and other trade specific specification sections shall apply to this section.

B. Owner’s Project Requirements and Basis of Design documents are included by reference for information only.

C. ASHRAE Guideline 0-2005, The Commissioning Process
1.3 SUMMARY

A. This section includes general requirements that apply to the implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related sections include the following:
   1. Section 013300 Submittal Procedures
   2. Section 017823 Operation and Maintenance Data
   3. Section 017900 Demonstration and Training
   4. Section 210800 Commissioning of Fire Suppression
   5. Section 220800 Commissioning of Plumbing Systems
   6. Section 230800 Commissioning of HVAC Systems
   7. Section 260800 Commissioning of Electrical Systems
   8. Section 270800 Commissioning of Communications
   9. Section 280800 Commissioning of Electronic Safety and Security
   10. Division 21 Fire Suppression
   11. Division 22 Plumbing
   12. Division 23 Heating Ventilating and Air Conditioning
   13. Division 26 Electrical
   14. Division 27 Communications
   15. Division 28 Electronic Safety and Security

1.4 DEFINITIONS

A. Acceptance - A formal action, taken by a person with appropriate provider (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

B. Approval - Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the contract documents.

C. Basis of Design - A document that records the concepts, calculations, decisions, and product selections used to meet the owner’s project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

D. Checklists, Construction Checklists, Installation Checklists, or Pre-Functional Checklists - Checklists that are developed by the CxA and completed by the Construction Team during all phases of the construction process to verify that materials, equipment, assemblies, and systems are installed in accordance with the Contract Documents.
E. Commissioning Authority or Agent (CxA) - The entity identified by the owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.

F. Commissioning Plan (CxP) - A document developed by the CxA that outlines the organization, schedule, roles and responsibilities, and documentation requirements of the Commissioning Process. The CxP is initially developed in the design phase and updated throughout the construction and closeout process.

G. Commissioning Process - A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements.

H. Commissioning Team - The individuals who through coordinated actions are responsible for implementing the commissioning process.

I. Data logging - The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.

J. Deferred Performance Tests (DPTs) - Performance tests that are performed, at the discretion of the CxA, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed.

K. Deficiency, Non-Compliance, Non-Conformance - A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents.

L. Factory Testing - Testing of equipment on-site or at the factory, by factory personnel, with or without an owner’s representative present.

M. Issues Log - A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the commissioning team during the course of the commissioning process.

N. Nominal Group Technique - A formal, structured brainstorming process used to obtain the maximum possible ranked input from a variety of viewpoints in a short period of time. The typical approach is a workshop session where a question is presented, the attendees each record their responses on a piece of paper, the individual responses are recorded on a flip chart without discussion in a round robin fashion, all of the responses are discussed, and the participants rank their top five responses.
O. Owner’s Project Requirements - A written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This is also referred to as the Project Intent or Design Intent.

P. Quality Based Sampling - A process for evaluating a sub-set (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.

Q. Seasonal Performance Tests - Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.

R. Startup - The initial starting or activating of dynamic equipment, including completing construction checklists.

S. Systems Manual - A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the owner during the occupancy and operations phase.

T. Functional Performance Test (FPT) - A protocol written by the CxA that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. Performance testing includes the dynamic functions and operations of equipment and systems using manual or monitoring methods under various levels of operation. Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system’s sequences of operation and components are verified to respond as the sequences state.

U. Training Plan or Instruction Program - A written document that details the expectations, schedule, and deliverables related to the training of project operating and maintenance personnel, users, and occupants.

V. Verification - The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner’s Project Requirements.

W. Trending – The monitoring, by a building management system or other electronic data gathering equipment, and analyzing of the data gathered over a period of time.
1.5 COORDINATION

A. Coordination of the Cx process is the responsibility of all Cx Team members.

B. The CxA coordinates the commissioning activities through the construction manager or general contractor. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.

C. The CxA, through the Owner or CM, will provide sufficient notice to the contractor for scheduling commissioning activities with respect to the Owner’s participation. The contractor will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

1.6 REMOBLIZATION AND RETESTING FEES

A. In general, CxA testing will include one test of each equipment and system and one day of retesting to verify that any deficiencies have been corrected. The cost of any additional testing will be deducted from the Contractor’s final payment by the Owner.

B. In the event that testing is scheduled in advance with the Contractor and testing is unable to be performed through no fault of the Owner and the CxA is not notified within 48 hours, the cost of the travel and time will be deducted from the contractor’s final payment by the Owner.

1.7 COMMISSIONING PLAN

The CxA will update the Commissioning Plan, originally developed in the Design Phase, to incorporate construction phase activities. Cx activities and milestones shall be incorporated into the project schedule by CM. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

A. Commissioning during construction begins with an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members. This meeting shall be scheduled by the CM within 30 days of the award of contracts related to commissioned systems and equipment, or 7 days from the initiation of the commissioning process if the contracts are already awarded.

B. Additional meetings will be required throughout construction, scheduled by the CxA, through the owner or CM, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems. In general, the frequency of these meetings is as follows: bi-weekly during the early construction process and demolition, weekly during the construction and rough-in process, and weekly during the testing process.
C. The CxA reviews submittals for all commissioned equipment and systems parallel with the Design Team for compliance with the OPR.

D. The construction checklists, developed by the CxA, are to be completed by the contractor (or their subcontractors), before and during the startup process and verified by the CxA.

E. The CxA witnesses selected assembly mock-ups and equipment and system start-up. Contractors are required to provide and utilize manufacturer-developed start-up forms for equipment.

F. The CxA develops equipment and system functional performance test (FPT) procedures. The FPT’s are executed by the contractor and witnessed and documented by the CxA.

G. The CxA reviews the O&M documentation for completeness.

H. The CxA coordinates the training plan provided by the contractor.

I. Deferred performance testing will be conducted as required.

1.8 COMMISSIONING TEAM

A. Members appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of each contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members appointed by Owner:
   1. CxA - An entity identified by the owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
   2. Representatives of the facility Users and Operation and Maintenance personnel.
   3. Architect and engineering design professionals.

1.9 RESPONSIBILITIES

Understanding and defining the roles of each participant is vital to the success of the Commissioning Process. This provides an outline of the responsibilities of each participant in the Commissioning Process. These responsibilities are typically formalized in the contracts between the Owner and the various parties and this section is not intended to supersede or negate any contracted relationships.

A. Owner (or Designated Representative):
1. Include the design professionals’ Commissioning related responsibilities and scope of work in the design request for proposal and contract.

2. Oversee the development of the Owner’s Project Requirements and approve any changes.

3. Designates a representative, ideally from the building’s operations and maintenance team, to participate in the Commissioning Process including

4. Design Phase coordination meetings

5. Construction Phase coordination meetings

6. Informal owner-training as equipment is installed and started

7. Maintenance orientation and inspections

8. System testing and verification meetings

9. Functional procedure review meetings before testing of systems

10. Training sessions

11. Verification demonstrations

12. Systems and assemblies tests

13. Final review at acceptance meeting

14. Review and approve any changes made to the Owner’s Project Requirements

15. Review and approve the Construction Documents

16. Videotape training sessions and construction progress

17. Review, comment on, and accept the Commissioning Authority’s progress and final reports

B. Commissioning Authority (CxA):
The Commissioning Authority is responsible to verify that the Owner’s Project Requirements for the project are satisfactorily achieved. The CxA is comprised of building commissioning experts who maintain a broad understanding of all aspects of building construction, maintenance, and operations. Specific tasks performed by the CxA include:

**Design Phase**

1. Assemble a commissioning team, hold a scoping meeting and identify responsibilities.

2. Develop a draft design-phase commissioning plan.

3. Attend commissioning meetings as needed with project coordinator and design team.

4. Review the Owner Objective documentation (design intent) for clarity and completeness.

5. Coordinate the commissioning work during design.

6. Develop and update the design phase commissioning plan.

7. Perform focused review of the design, drawings and specifications at various stages of development (during design development and contract document phases) as described in Exhibit 1 of the RFP.

8. Direct and Review the development and maintenance of Design Record.
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documentation by design team members (Design Intent, Design Narratives, Basis of Design).

9. Develop a draft construction phase commissioning plan using an Owner-approved outline.

10. Develop full commissioning specifications for all commissioned equipment. Coordinate with and integrate into the specifications of the architect and engineers. The specifications will be consistent in content, rigor and format to the referenced standards.

11. The commissioning specification will include:

12. A detailed description of the responsibilities of all parties.

13. Details of the commissioning process.

14. Reporting and documentation requirements, including formats; alerts to coordination issues, deficiency resolution; construction checklist and start up requirement.

15. The functional testing process.

16. Specific functional test requirements, including testing conditions and acceptance criteria for each piece of equipment being commissioned.

17. Coordinate control integration meetings where the owner, electrical engineers, mechanical engineers and CxA discuss integration issues between equipment, systems and disciplines to ensure that integration issues and responsibilities are clearly described in the specifications.

18. Review documents and responses from A/E to ensure that all previous comments have been addressed by the appropriate project number.

**Bid Phase**

1. Attend a pre-bid meeting to answer commissioning related questions.

**Construction Phase**

1. Perform the tasks and functions to be incorporated in the specifications ascribed to the CxA.

2. Coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties. Frequently updated timelines and schedules and technical expertise.

3. Coordinate the commissioning work, with the contractor, architect and owner’s representatives to ensure that commissioning activities are being scheduled into the master schedule.

4. Revise the construction phase commissioning plan developed during the
design phase as required to include refined scope and schedule.

5. Plan and conduct commissioning meetings and distribute minutes.

6. Request and review information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures. Before startup, gather and review current control sequence and interlocks. Work with the architect so that the CxA/A/E comments are combined into one review submitted to the contractor.

7. Review coordination drawings to ensure that trades are making a reasonable effort to coordinate work. Coordinate submittal review with the architect so that the CxA/A/E comments are combined into one review submitted to the contractor.

8. Write and distribute construction checklists for commissioned equipment.

9. Develop an enhanced start-up and initial systems checkout plan with contractors for selected equipment.

10. Perform site visits to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.

11. Witness HVAC piping pressure test and flushing to be confident that proper procedures were followed in accordance with specifications. Include testing documentation in the commissioning record.

12. Witness any ductwork testing and cleaning sufficient to be confident that proper procedures were followed in accordance with specifications. Include documentation in the Commissioning Record.

13. Provide construction checklists for equipment/systems within the scope of work to the contractors.


15. Document system startup by reviewing start-up reports and by selected site observations.

16. Approve air and water systems balancing by spot testing and by reviewing completed reports and by selected site observation. Coordinate submittal review with the architect so that the CA/A/E comments are combined into one review submitted to the contractor.

17. With assistance and review from the installing contractor, CA will write functional performance test procedures for equipment and systems. This will include manual functional testing, energy management control system trending and may include stand alone data-logging monitoring. Submit to owner for...

19. Coordinate, witness and document manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved. The functional testing shall include operating the systems and components through each of the written sequences of operation, and other significant modes and miscellaneous alarms, power failure, security alarm when impacted and interlocks with other systems or equipment. Sensors and actuator shall be calibrated during construction check listing by the installing contractors, and spot-checked by the CxA during functional testing.

20. Tests on respective HVAC equipment shall be executed, if possible, during both the heating and cooling season. However, some overwriting of control values to simulate conditions shall be allowed. Functional testing shall be done using conventional manual methods, control system trend logs, and read-outs or stand-alone data loggers, to provide a high level of confidence in proper system function, as deemed appropriate by the CxA and the Owner.

21. Prepare test plans for, assist with execution of, and document tests of commissioned equipment overseen by regulatory authorities and ensure that such tests meet the testing rigor desired by the Owner.

22. Maintain a master issues log and a separate record of functional testing. Report all issues as they occur directly to the owner’s representative and the architect. Provide directly to the owners representative and the architect written progress reports and test results with recommended actions.

23. Review equipment warranties to ensure that the Owner’s responsibilities are clearly defined.

24. Oversee and approve the training of the Owner’s operating personnel.

25. Review and approve the preparation of the O&M manuals for commissioned equipment. Coordinate submittal review with the architect so that the CxA/A/E comments are combined into one review submitted to the contractor.

26. Compile a commissioning Record, which shall include:
   a. A brief summary report that includes a list of participants and roles, brief building description, overview of commissioning and testing scope, and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the CxA regarding the adequacy of the equipment,
documentation and training meeting the contract documents in the following areas:

i. Equipment meeting the equipment specifications.

ii. Equipment installation.

iii. Functional performance and efficiency.

iv. Equipment documentation.

v. Operator training.

b. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented.

c. Also included in the Commissioning Record shall be the issues log, commissioning plan, progress reports, submittal and O&M manual reviews, training record, test schedules, construction checklists, start-up reports, functional tests, and trend log analysis.

d. Provide 2 paper copies and one electronic copy of the Commissioning Record to the Owner.

27. Comply with the requirements of LEEDTM 2009 Edition 2.2 EA prerequisite 1, Fundamental Building Systems Commissioning and EA credit 3, Enhanced Commissioning. Complete all paperwork required for LEEDTM submittal of these points, including an audit if required.

**Warranty Period**

1. Coordinate and supervise required opposite season or deferred testing and deficiency corrections and provide the final testing documentation for the Commissioning Record and O&M manuals.

2. Return to the site at 10 months warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have with operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals.

3. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports and documents and requests for services to remedy outstanding problems. The CxA is not responsible for correcting deficiencies.

C. Design Team

The primary role of the Design Team is to translate the Owner’s Project Requirements into a
complete design. Relative to commissioning, the design team’s responsibilities vary depending on the specific project and contract, but may include:

1. Participate in the development and documentation of the initial Owner’s Project Requirements.
2. Document revisions to the Owner’s Project Requirements as approved by the Owner.
4. Integrate the Commissioning Process requirements provided by CxA in the Contract Documents.
5. Respond to Commissioning Team design review comments.
7. Review and incorporate the CxA’s comments from submittal reviews.
8. Participate in the initial Operation and Maintenance personnel training sessions. Include a presentation of the project’s Basis of Design and descriptions of the associates systems.
10. Review the CxA’s reports and logs and comment as appropriate.
11. Review and comment on the final Cx Report.

D. Construction Manager

The Construction Manager provides management, technical, and administrative expertise during the Construction phase to ensure the building Owner’s goals relating to schedule and quality are met. The Construction Manager’s responsibilities related to the Commissioning Process typically include:

1. Include any costs for Commissioning Process activities in the contract price.
2. Include Commissioning Process requirements and activities in all contractors’ contracts.
3. Ensure necessary accessibility to all equipment to allow for proper operation and maintenance of the building.
4. Provide individuals with the required background and authority to implement the Commissioning Process activities as outlined in the Contract Documents.
5. Issue a statement at the end of the project certifying that all work has been completed in accordance with the Contract Documents and the facility is operational.
6. Respond to Commissioning Process reports and correct deficiencies identified during installation verification or functional testing.
7. Review and comment on the final Cx Report.

E. Contractors

Depending on the nature and the size of the project, many different contractors may be involved in the Commissioning Process. The various contractors may include the building contractors (general, mechanical and electrical), the testing, adjusting, and balancing contractor, the building automation system contractor and others as required by the contract documents. As a member of the Commissioning Team, the responsibilities of the various building contractors include:

1. Include any costs for Commissioning Process activities in the contract price.
2. Include Commissioning Process requirements and activities in all subcontracts or equipment purchases.
3. Ensure the cooperation and participation of all subcontractors and manufacturers of equipment or systems to be commissioned.
4. Attend Commissioning Team meetings.
5. Include Cx-related milestones in the construction schedule.
6. Implement the training program as described in the Contract Documents. Coordinate related activities with the CxA.
7. Provide submittals to the Owner, Design Team, and CxA as detailed in the Contract Documents.
8. Notify the CxA when systems and assemblies are ready for installation verification and testing. For repetitive assemblies, notify the CxA upon the completion of the prototype for a First Piece or Mock-Up review.
9. Demonstrate the performance of assemblies and operate systems as required to fulfill the requirements of the Functional Test Procedures detailed in the Commissioning Plan and the Contract Documents.
10. Complete the Construction Checklists as the work is completed. Provide completed copies to the CxA at regular intervals for verification.
11. Maintain the Project Record Documents in accordance with the requirements of the Contract Documents.

F. Manufacturers

The suppliers of major equipment are required to support the Commissioning Team in the following manner:
1. Provide all information required for the proper Start-up and Operation and Maintenance of the system or assembly in the initial submittal, as detailed in the Contract Documents.

2. Provide the requirements to maintain the warranty in the initial submittal, as detailed in the Contract Documents.

3. Coordinate and provide results of all factory tests required in the Contract Documents.

4. Participate in the training process as detailed in the Contract Documents.

5. Demonstrate operation and performance of equipment and assemblies as detailed in the Contract Documents.

G. Operations and Maintenance Staff

1. The Operations and Maintenance staff will participate in the Commissioning Process in the following areas:

2. Define Operations and Maintenance related requirements of the building.

3. Participate in design review for O&M impacts.

4. Review maintenance manual, record drawing and documentation requirements developed by the Design Team.

5. Define training program requirements.


7. Attend contractor and vendor training sessions.

1.10 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

A. The following equipment/systems will be commissioned in this project:
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

1. Heating Systems
2. Steam Systems
3. Air Handling systems and equipment
   a. Ductwork
   b. VAV boxes
4. HVAC Control systems
5. Plumbing systems
6. Life safety systems including:
   a. Fire alarm systems
   b. Standpipe and sprinkler systems
   c. Fire pump and controller
   d. All piping and ancillary hardware
7. Electrical systems consisting of:
   a. Substation transformers
   b. Switchboards
   c. Motor Control Centers
   d. Power and lighting panel boards
   e. Lighting fixtures
   f. Lighting controls
8. Emergency power supply systems
9. Indoor air quality

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required performance testing shall be provided by the contractor for the equipment being tested. This includes, but is not limited to, two-way radios, meters, and data recorders. Data recorders may be provided by the CxA at the option of the CxA.

B. Special equipment, tools, and instruments required for testing equipment according to these contract documents shall be included in the contractor’s base bid price and shall be turned over to the owner at Project close-out.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the
following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards within the past year to an accuracy of 0.5 degree F and a resolution of + or - 0.1 degree F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer’s recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 OVERVIEW

Through the Construction Phase of the project, it is the responsibility of the CxA to coordinate and direct the Commissioning Process activities in a logical, sequential, and efficient manner using protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties.

3.2 CONDUCT PRE-CONSTRUCTION MEETING

The Pre-Construction Meeting is an opportunity for the CxA to meet with the Construction Team and discuss the general Commissioning Process. It is the ideal time to identify Commissioning Team members, discuss the integration of the Commissioning Process Schedule with the Construction Schedule, review the submittal review requirements, review the inspection and testing process, and develop the formal lines of communication between all parties.

3.3 CONDUCT REGULAR COMMISSIONING MEETINGS

Once the Commissioning Team (Cx Team) has been formed, regular Commissioning Meetings are held. These meetings vary in frequency based upon the activity level at the time, but generally are coordinated to coincide with Construction Meeting days for convenience. At the Commissioning Meetings, past Commissioning Process activities are reviewed, future Commissioning Process activities are planned and coordinated, Commissioning documentation is requested and exchanged, and the Commissioning Schedule is updated and integrated into the Construction Schedule. The CxA will request all documentation necessary to develop the installation checklists, contractor start-up checklists, and the functional performance tests at these meetings and review the draft versions of these documents with the contractors that are responsible for implementing them. The CxA leads these meetings, records the minutes, and distributes the minutes with action items to all Cx Team members.

3.4 CONTRACTOR SUBMITTAL REVIEW

The CxA will review the Contractor submittals coincident with the Design Team and provide comments to the Design Team for inclusion with their review so a single set of review comments can be provided to the Contractors. The reviewed submittals will include all commissioned equipment information and coordination drawings that include commissioned equipment and
systems, control drawings and sequences, and interfaces and interlocks between systems. In addition, the CxA will periodically review the final Design Team comments to ensure a quality review process.

3.5 MAINTAIN ISSUES LOGS

Throughout the Construction Process, the CxA will maintain a Commissioning Issues Log. This log will document all Construction Phase issues through a sortable database that identifies the following fields.

A. The responsible party, either Construction Team member, Design Team member, or Owner
B. The exact location of the issue (floor and room)
C. The applicable system component, i.e. lighting, a specific piece of equipment, or a system.
D. The project impact
E. A severity
F. A deficiency code, i.e. craftsmanship, non-compliance, etc.
G. A reference to the Contract Documents
H. A detailed description of the issue
I. A status, i.e. complete, incomplete, accepted, unverifiable
J. A code indicating whether the issue was identified during installation inspections or functional performance testing.

The issues log will be distributed and reviewed at each Commissioning Meeting and each issue will be tracked by the CxA until it is resolved.

3.6 CONSTRUCTION CHECKLISTS

In general, the Contractors will be responsible for completing documentation related to the installation, start-up, and testing of all commissioned equipment and systems. This documentation will be provided to the contractors in a PDF file to be kept on-site and be completed through the use of either paper or electronic forms at the contractor’s discretion. However, all subcontractors must utilize the same system for checklists (i.e., all paper, same electronic system, etc).

A. Delivery Book (paper or electronic)
   The Delivery Book may be either a three-ring binder or a virtual notebook and will be maintained in duplicate with one copy on site in the Construction Manager’s field office and
one copy off-site in the CxA’s office. It is the responsibility of the Construction Team to keep the Book updated and provide copies of additions and changes to the CxA at Commissioning Meetings. The Book will include all of the Commissioning Process documentation required for the installation and start-up of commissioned equipment and systems.

B. Installation Checks

The Construction Team will be responsible for completing installation checklists for all commissioned systems and equipment. The checklists will include best practices related to the specific equipment or system, highlights of required installation details from the drawings and specifications, and equipment manufacturer, model number, serial number, and capacity verification information. It is intended that these checklists will be generally limited to a single page per equipment and system. The CxA will use sampling strategies to field verify the proper completion of the checklists with sampling rates determined based upon the success of the verification process, the quantity of each type of equipment, and the relative importance of the equipment’s operation related to the overall building operation.

C. Start-up Checks

In order to achieve successful equipment start-ups, the contractor will provide the manufacturer’s start-up checklists for commissioned equipment and systems. The goal of the checklists are to make sure that equipment and systems are operable at the time of the scheduled start-up, all appropriate parties are in attendance, manufacturer’s recommended procedures are followed, and warrantees are not voided and equipment damaged by improper start-up procedures. Start-ups are not to proceed without the appropriate forms.

3.7 SITE OBSERVATIONS

Periodically throughout the Construction process, the CxA will perform site visits to observe component and systems installations. These visits will be strategically planned to coincide with selected planning and job-site meetings, installation milestones, component and assembly mock-ups, and equipment and system start-ups. The CxA will use these site visits to verify the proper completion of installation and start-up checklists, witness HVAC pipe and duct cleaning and testing, review and approve the air and water systems balancing by selective testing, and generally track the progress of the construction. A field report will be provided at the conclusion of each visit documenting the tasks accomplished during the visit.

3.8 READINESS CHECKLISTS

Each piece of equipment will receive a Readiness Checklist that is to be completed and provided to the CxA prior to the scheduling and commencement of functional performance testing. The checklists will be used as a mechanism for the contractors to certify that they have completed the installation checklists and equipment and system start-ups, and that they have pretested the systems and equipment in preparation for the final testing by the CxA. Copies of
the functional test procedures will be provided to the contractors in advance for their use in pretesting.

3.9 TRAINING AND O&M REVIEW

The Owner’s operations and maintenance staff will commence training during the construction phase through a combination of formal and informal training activities. Informal activities will include construction walkthroughs and participation (at their option) in the functional performance testing process. Additional training is described in 017900 DEMONSTRATION AND TRAINING.

The CxA will review and approve the preparation of the Operations and Maintenance (O&M) manuals for commissioned equipment. This review will be coordinated with the Design Team to provide one submittal review to the Contractor. The CxA will coordinate with the Contractor to have the O&M manuals ready and available for use in the training process.

3.10 TESTING

The performance of the testing of all commissioned equipment and systems is the responsibility of the Contractors. The CxA will develop the functional performance tests with the assistance of the installing contractors, coordinate the testing process, and witness the tests that are performed by the Contractors. In addition, the CxA will prepare plans for, assist with execution of, and document tests of commissioned equipment overseen by regulatory authorities and ensure that such tests meet the rigor desired by the Owner. The CxA will coordinate the retesting of equipment until satisfactory performance is achieved.

The functional performance testing will include operating the systems and components through each of the written sequences of operation, other significant modes and miscellaneous alarms, power failure, and security alarm when impacted by and interlocked with commissioned equipment. Sensors and actuators shall be calibrated during construction check listing by the installing contractors and spot checked by the CxA during functional testing. Tests on HVAC equipment shall be done, if possible, in their proper operating season (cooling in summer, heating in winter). Any equipment that operates in both seasons, such as the heat pumps, should ideally be tested in both seasons. However, if this is not possible, some manipulation of setpoints and control points will be done to simulate the necessary conditions. Functional testing will be done using conventional manual methods, control system trend logs, and stand-alone data loggers as required to provide a high level of confidence in proper system function, as deemed appropriate by the CxA and the Owner. A separate report will be provided that includes all of the issues identified during the testing process.

As a component of the test procedures, the CxA will identify specific system trends to be set up and then analyze the trend and monitoring data as a method of verifying performance.

PART 4 - OCCUPANCY AND OPERATIONS PHASE
4.1 FINAL COMMISSIONING PROCESS REPORT

At the completion of the Commissioning Process, the CxA will provide a final report based on the framework of this Commissioning Plan. An Executive Summery will be included that provides a summary of the participants and their roles, a brief building description, an overview of the commissioning and testing scope, and a general description of testing and verification methods. Included with the summary will be a matrix that provides the disposition of the CxA regarding the adequacy of the commissioned equipment and system in the following five areas: Equipment meeting the equipment specifications, Equipment installation, Functional performance and efficiency, Equipment documentation, and Operator training.

The final report will specifically identify all outstanding non-compliance issues, recommendations for improvement to equipment or operations, future actions required, and recommended changes to the Commissioning Process. In addition, the Report shall include a final issues log with all issues identified through the Commissioning Process, original commissioning plan, progress and field reports, submittal and O&M manual reviews, training record, test schedules, construction checklists, start-up reports, functional tests, and trend log analysis.

Two paper copies and one electronic copy of the report will be provided to the Owner.

4.2 SEASONAL TESTING

Any equipment or system that cannot be adequately tested at the time of the initial testing due to seasonal operating issues will be retested in their primary operating season. Whenever possible, systems will be tested under load to verify system capacity and function.

4.3 ONGOING TRAINING

The CxA will oversee and approve the Contractor-provided training of the Owner’s operating personnel. The training agendas, attendance logs, and materials will be documented by the CxA and any additional or supplemental training required for the Owner’s operating personnel to properly and efficiently operate the building will be provided by the CxA.

4.4 WARRANTY REVIEW

The CxA will return to the site 10 months into the 12 month warranty period and review with facility staff the current building operation and condition of outstanding issues related to the original and seasonal commissioning. Any issues that may come under warranty or under the original construction contract will be identified and the CxA will assist the facility staff in developing reports, documents, and requests for services to remedy outstanding problems. The CxA is not responsible for correcting deficiencies.

4.5 LESSONS LEARNED MEETING

The CxA will coordinate and lead a Lessons Learned meeting with the Owner, the Owner’s operating personnel, and representatives of the Design and Construction Teams. Using the Nominal Group Technique, the CxA will develop a consensus of the building operation, the relative success of the project, and recommendations for improvements to this and future projects.
These results of this process will be distributed to all participants and added to the O&M manuals.

4.6 LEED- 2009 EDITION DOCUMENTATION

In addition to the reports described above, all paperwork required to complete the requirements of LEED-2009 EA Prerequisite 1, Fundamental Building Systems Commissioning and EA Credit 3, Additional Commissioning will be provided. This includes submittal paperwork and any work required for audits of these points.

END OF SECTION 019113
COMMISSIONING OF FIRE SUPPRESSION
SECTION 210800 – COMMISSIONING OF FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process to the fire suppression systems, assemblies, and components.

B. Related Sections include the following:
   1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
   2. Division 21 Fire Suppression
   3. Division 28 Electronic Safety and Security for fire alarm interaction and requirements

1.3 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.

D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
E. Official: State or Local official having jurisdiction over the conveying systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
   1. Wet sprinkler piping and equipment including fire pump and jockey pump

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
   1. The system or assembly is completely installed, functional, and documented.
   2. Work performed by other trades, but essential for this system or assembly’s operation, is complete (e.g., electrical components are wired and power is provided)
   3. All contractor-performed start-up procedures and tests are complete and documented.
   4. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
   1. Wet sprinkler systems
   2. Fire alarm system interactions
B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
   2. Division 21 Fire Suppression
   3. Division 28 Electronic Safety and Security

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

SAMPLE
Installation Checklist
Sprinkler Piping- Second Floor

Schedule ID# from drawings:  Fire Protection
Reference Specification:  15300
Reference Drawing:  F-101
Location:  Second Floor

Model Verification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specified</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumps:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QTY/HP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage/Ph</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Installation Checks

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Pass/Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verify sprinkler piping is run level.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verify sprinkler piping is schedule 40 black steel piping and has been provided with the appropriate fittings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Piping 1” to 2” Threaded Fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Piping 2-1/2” and greater Victaulic Fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Verify piping has been properly supported.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Verify that the “Wet” system piping is not run in main telephone, electric, and data rooms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Verify that standpipe and hose valve cabinets are installed at each stair landing at 48” A.F.F.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Verify that floor zone control valve assembly and drain piping has been installed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verification</td>
<td>Approval</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Verify piping has been provided with seismic bracing where required.</td>
<td>☐ ☐</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Verify that auxiliary drains have been provided for all trapped piping.</td>
<td>☐ ☐</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Verify piping has been clearly identified with the proper color coding.</td>
<td>☐ ☐</td>
<td></td>
</tr>
</tbody>
</table>

**Approvals (only one required)**

<table>
<thead>
<tr>
<th>Role</th>
<th>Name (printed neatly)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor/Manuf. Rep.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Administrator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning Agent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SAMPLE
Functional Performance Test
Fire Pump

1. Participants

<table>
<thead>
<tr>
<th>Name/Representing</th>
<th>Participation (Testing, Witness, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

(Y/N) An as-built version of the controls submittal has been provided.

(Y/N) A start up service report has been provided by a factory-authorized service representative.

(Y/N) The controls contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. CC initials: __ __. Date: __ __.

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: __ __. Date: __ __.

(Y/N) Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc. that were changed to accommodate testing:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-Test Values</th>
<th>Returned to Pre-Test Values ✓</th>
<th>Parameter</th>
<th>Pre-Test Values</th>
<th>Returned to Pre-Test Values ✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Pump Status</td>
<td></td>
<td></td>
<td>Jockey Pump Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Pump Inlet Valve Status</td>
<td></td>
<td></td>
<td>Jockey Pump Inlet Side Valve Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Pump Discharge Valve #1 Status</td>
<td></td>
<td></td>
<td>Wet Alarm Check Valve Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Pump Discharge Valve #2 Status</td>
<td></td>
<td></td>
<td>Fire Pump Test Header Valve Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Pump Bypass Line Valve #1 Status</td>
<td>Fire Pump Bypass Line Valve #2 Status</td>
<td>Fire Dept Connection Valve Status</td>
<td>Low Pressure Alarm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>--------------------------------------</td>
<td>----------------------------------</td>
<td>-------------------</td>
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<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. **Sensor Calibration Checks.** The sensors listed below are to be checked for calibration and adequate location.

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Location OK</th>
<th>BAS Value</th>
<th>Measured Value</th>
<th>Pass Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td>Y / N</td>
<td></td>
</tr>
</tbody>
</table>

1 Sensor location is appropriate and away from causes of erratic operation.

**Comments:**

Sensor location is appropriate and away from causes of erratic operation.

4. **Device Calibration Checks.** The actuators or devices listed below are to be checked for proper operation and/or calibration.

<table>
<thead>
<tr>
<th>Device or Actuator</th>
<th>Procedure / State</th>
<th>BAS Value</th>
<th>Site Observation</th>
<th>Pass Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Pump Inlet Valve Status</td>
<td>1. On</td>
<td></td>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td>2. Off</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Fire Pump Discharge Valve</td>
<td>1. Alarm</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>#1 Tamper Switch Status</td>
<td>2. Normal</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Fire Pump Discharge Valve</td>
<td>1. Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>#2 Tamper Switch Status</td>
<td>2. Closed</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Fire Pump Bypass Line Valve</td>
<td>1. Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>#1 Tamper Switch Status</td>
<td>2. Closed</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Fire Pump Bypass Line Valve</td>
<td>1. Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>#2 Tamper Switch Status</td>
<td>2. Closed</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Jockey Pump Inlet Side Valve</td>
<td>1. Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Device or Actuator</td>
<td>Procedure / State</td>
<td>BAS Value</td>
<td>Site Observation</td>
<td>Pass Y/N</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------------</td>
<td>-----------</td>
<td>------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Tamper Switch Status</td>
<td>2. Closed</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Fire Pump Test Header Valve</td>
<td>1. Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Tamper Switch Status</td>
<td>2. Closed</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Fire Dept Connection Valve</td>
<td>1. Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Tamper Switch Status</td>
<td>2. Closed</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
</tbody>
</table>

5. Notes
### Functional Testing Record

<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 1      | JOCKEY PUMP AUTOMATIC START | 1. With jockey pump in “AUTO” position lower sprinkler pressure by opening system drain valve.  
2. Close system drain valve | 1. The jockey pump will start when the system pressure reaches the pre-set turn on setting  
2. The pump runs until the system pressure reaches the shut off setting at which time the jockey pump will stop. | Y/N |   |
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 2      | FIRE PUMP AUTOMATIC START | 1. With the jockey pump in the “ON” position, open the “Alarm Test Module” valve to reduce system pressure.  
2. Close the “Alarm Test Module” valve. | 1. The Fire Pump will start when the system pressure reaches the pre-set fire pump “start” setting  
2. The system returns to the proper pressure. The fire pump runs for a predetermined time and shuts off at the end of that time period. | Y/N |   |
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 3      | FIRE PUMP RUNNING ON EMERGENCY GENERATOR     | 1. If equipped, activate the Emergency Generator “RUN” switch.  
2. With the emergency generator running and the jockey pump switch in the “OFF” position reduce the pressure in the sprinkler system by opening the Alarm Test Module valve  
3. Close test valve  
4. Return generator switch to “Normal” position | 1. Emergency generator starts. Fire pump is now fed from generator.  
2. Fire pump runs  
3. Fire pump turns off after a predetermined time period  
4. Fire pump power is fed from normal power and Emer. Generator shuts off | Y/N |       |
END OF TEST

END OF SECTION 210800
COMMISSIONING OF PLUMBING
SECTION 220800 – COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY
   A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.
   B. Related Sections include the following:
      1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
      2. Division 22 – Plumbing

1.3 DEFINITIONS
   A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This Plan is included in Volume 4 of these specifications.
   B. CxA: Commissioning Authority.
   C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
   D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
   E. Official: State or Local official having jurisdiction over the conveying systems
   F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
   1. Plumbing fixtures and equipment
   2. Domestic hot water heaters
   3. Solar domestic hot water system
   4. Gas piping and distribution

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
   1. The system or assembly is completely installed, functional, and documented.
   2. Work performed by other trades, but essential for this system or assembly’s operation, is complete (e.g., electrical components are wired and power is provided)
   3. All contractor-performed start-up procedures and tests are complete and documented.
   4. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
   1. Plumbing fixtures and equipment
   2. Domestic hot water equipment and systems

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
2. Division 22 – Plumbing

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS
Sample Installation Checklist

**General Plumbing Pipe Installation**

Schedule ID# from drawings: Piping System: _________________ Location

Reference Specification: 220000
Reference Drawing:

Model Verification

<table>
<thead>
<tr>
<th>Construction Standards</th>
<th>Specified</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Miscellaneous</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Installation Checks

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Pass/FAIL</th>
<th>Comment</th>
</tr>
</thead>
</table>
| 1  | Water piping:  
  1. Below ground water service piping 4” and larger shall be cement lined ductile iron pipe and fittings.  
  2. Above ground potable and non-potable water systems: ½”-4” Type L copper tubing with soldered joints. | ☐ ☐ |        |
| 2  | Gas Piping:  
  1. Aboveground exterior and interior gas and vents shall be schedule 40 steel pipe  
  2. Fittings 2-1/2” and less shall be screwed type for 3” and larger shall be welded. | ☐ ☐ |        |
| 3  | Verify sleeves are installed for pipes passing through concrete walls or floors, ½” air space around pipe to sleeve and sealed to make smoke/fire proof. | ☐ |        |
| 4  | Verify that proper provisions for expansion and contraction of the hot water piping systems piping is provided by means of pipe bends, pipe offsets, swing connections or changes in direction of piping. | ☐ |        |
| 5  | Verify that hose and drain valves are provided for complete draining of the system. | ☐ |        |
| 6  | Verify that all high point in closed water piping systems have either equipment venting or manual vents installed. | ☐ |        |
| 7  | Natural Gas piping:  
  1. Verify piping pitches to drains at drip legs at least 6” long.  
  2. Verify shut off valve is installed at each equipment connection on the downstream side of any regulators and installed in accessible location.  
  3. Piping is securely fastened, separately hung and not strapped or supporting other devices. | ☐ ☐ ☐ |        |
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

Identification:

1. Verify color coded piping identification markers on piping systems are installed including flow direction markings: markers installed: on each side of wall penetrations, at each valve, at tee fittings, and base of risers, marking spacing not to exceed.
2. Identify equipment such as pumps, compressors, water heaters, and tanks with names and equipment numbers.

Verify Plumbing **piping, fittings, and valves** Insulation:

- All interior water piping.
- Equipment including Heat exchanger and cold water chiller.
- All aboveground rainwater piping including drain bodies.
- All piping in exterior furred ceiling spaces and overhangs.
- All horizontal waste piping receiving cold water condensate.
- All water heaters.
- At handicapped sinks not equipped with a protective shroud.

<table>
<thead>
<tr>
<th>Approvals (only one required)</th>
<th>Name (printed neatly)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor/Manuf. Rep.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Administrator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning Agent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Commission of Plumbing Systems**

AKF

Commissioning of Plumbing Systems
220800- 5
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

Functional Performance Test
Plumbing Fixtures

1. Participants

<table>
<thead>
<tr>
<th>Name/Representing</th>
<th>Participation (Testing, Witness, etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Owners Representative</td>
<td></td>
</tr>
</tbody>
</table>

Party filling out this form ____________________________ Date of test __________

2. Prerequisite Checklist

a. □ An as-built version of the plumbing drawing has been provided.

b. □ The plumbing contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. PC initials: ________. Date: ________.

c. □ The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: ________. Date: ________.

3. Functional Testing Procedures

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>Fixture Type</th>
<th>Test Procedure</th>
<th>Expected Results</th>
<th>Pass/Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fixtures</td>
<td>Operate each faucet and water closet to verify water connections and pressure.</td>
<td>Fixtures will operate and drain. Automatic flush valves will not cause splashing. For sinks and lavs, hot water will be on the left, cold on the right.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Commissioning of Plumbing Systems

### Test Sequence

<table>
<thead>
<tr>
<th>Test Sequence</th>
<th>Fixture Type</th>
<th>Test Procedure</th>
<th>Expected Results</th>
<th>Pass/Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Fixtures</td>
<td>Measure hot water temperature at each sink and lavatory.</td>
<td>Water temp shall not exceed 115 degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fixtures</td>
<td>Operate all Electronic Sensors</td>
<td>All Sensor operated fixtures shall respond as designed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**END OF TEST**

**END OF SECTION 220800**
COMMISSIONING OF HVAC
SECTION 230800- COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. ASHRAE Guideline 1-2007, HVAC&R Technical Requirements for the Commissioning Process

C. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:
   1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
   2. Division 23 Mechanical
   3. Division 28 Electronic Safety and Security for interaction with fire alarm systems

1.3 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.

E. Official: State or Local official having jurisdiction over the HVAC&R systems.

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
1. Boilers and related equipment
2. Chillers and related equipment
3. Pumps and Drives
4. Hot water system
5. Chilled water system
6. Air Handling Units with Energy Recovery
7. Rooftop Air Handling Units
8. Split System Air Conditioning Units
9. Exhaust fans and systems
10. Supply or make-up air systems
11. Unit Ventilators
12. Fan Powered VAV
13. Specialty air removal/ventilation systems (including fans, ductwork and interconnection with air handling/supply systems)
14. Ductwork systems
15. Piping Systems
16. Terminal heating units (unit heaters, reheat coils, fin-tube, radiant ceiling panels)
17. Additional Items to be added as required

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
1. The system or assembly is completely installed, functional, and documented through checklists.
2. Work performed by other trades, but essential for this system or assembly’s operation, is complete (e.g., electrical components are wired and power is provided)
3. All contractor-performed start-up procedures and tests are complete and documented.
4. Preliminary trending data provided to verify actual system operation.
5. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
1. Boilers and related equipment
2. Chillers and related equipment
3. Pumps and Drives
4. Hot water system
5. Chilled water system
6. Air Handling Units with Energy Recovery
7. Rooftop Air Handling Units
8. Split System Air Conditioning Units
9. Exhaust fans and systems
10. Supply or make-up air systems
11. Unit Ventilators
12. Fan Powered VAV
13. Specialty air removal/ventilation systems (including fans, ductwork and interconnection with air handling/supply systems)
14. Terminal heating units (unit heaters, reheat coils, fin-tube, radiant ceiling panels)
15. Building automation system
16. HVAC, Test, Adjust, and Balance
17. Additional Items to be added as required

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
   2. Division 23 Mechanical

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.02 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS
### Installation Checklist

Roof Top Unit # _____________ Serving Room/Area/Floor ______________

#### Model Verification

<table>
<thead>
<tr>
<th></th>
<th>Specified</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inlet Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cool CFM / Heat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Installation Checks

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Pass / Fail</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verify the unit has been installed on a roof curb. Entire length and width under base shall be sealed for additional water management protection. (1.5500 2.42D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The piping cabinet shall have removable panels or optional access door of the same construction as unit door. (1.5500 2.42H)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Verify view windows are provided for all fan section access doors and is made of tempered glass. (1.5500 2.42K)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Verify that a factory mounted light fixtures are provided in all sections of the unit that have access doors. Provide individual light switches installed adjacent to access doors. (1.5500 2.42I)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Coils shall be removable by unbolting the wall panels in the coil section. Connections shall be clearly labeled on the outside of units. (1.5500 2.42O)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Verify filter section shall have filter racks, an access door for filter removal and block offs as required to prevent air bypass around filters. Units shall be supplied with 4” flat and 12” cartridge bag filters. (1.55500 2.42P)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Verify factory wired disconnect switches for each fan (VSDs are to be mounted in the building not within the rooftop unit). Also provide factory wired lights and GFI receptacles (two per unit). (1.5500 2.42V)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Provide smoke rated damper assembly for both supply and return air openings for RTU-1, 7 and 9. (1.5500 2.42W)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Provide isolation damper assemblies for both supply and return air openings for all rooftop units except RTU-1, 7 and 9. (1.5500 2.42X)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Verify the following piping components have been installed in the direction of flow for the CW/HW supply: (M4-2-0)

- Thermometer
- Butterfly Valve
- Strainer with hose end drain valve with cap and chain.
- Union
- ¾” Hose end drain valve with cap and drain.

Verify the following piping components have been installed in the direction of flow for the CW/HW return: (M4-2-0)

- Automatic Air Vent
- Union
- 2-Way Control Valve
- Union
- Butterfly Valve with Memory Stop
- Thermometer

<table>
<thead>
<tr>
<th>Approvals (only one required)</th>
<th>Name (printed neatly)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor/Manuf. Rep.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Administrator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning Agent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sample Functional Performance Test

Heat Recovery Rooftop Unit – ERV-2

1. Participants

<table>
<thead>
<tr>
<th>Name/Representing</th>
<th>Participation (Testing, Witness, etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

a. ☐ A completed and approved balancing report has been provided.

b. ☐ An as-built version of the controls submittal has been provided.

c. ☐ The controls contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. CC initials: ________. Date: ________.

d. ☐ The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: ________. Date: ________.

e. ☐ Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc., that have been changed to accommodate testing:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-Test Values</th>
<th>Returned to Pre-Test Values □</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupied space temperature heating setpoint</td>
<td></td>
<td>□</td>
</tr>
<tr>
<td>Occupied space temperature cooling setpoint</td>
<td></td>
<td>□</td>
</tr>
<tr>
<td>Frost Control temperature alarm setpoint</td>
<td></td>
<td>□</td>
</tr>
<tr>
<td>Occupied/Unoccupied</td>
<td></td>
<td>□</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-Test Values</th>
<th>Returned to Pre-Test Values □</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unoccupied space temperature heating setpoint</td>
<td></td>
<td>□</td>
</tr>
<tr>
<td>Unoccupied space temperature cooling setpoint</td>
<td></td>
<td>□</td>
</tr>
<tr>
<td>Occupied low space temperature alarm setpoint</td>
<td></td>
<td>□</td>
</tr>
<tr>
<td>Occupancy</td>
<td></td>
<td>□</td>
</tr>
<tr>
<td>Mode</td>
<td>Schedule</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Occupied Space</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humidity Setpoint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Limit Switch SP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. **Sensor Calibration Checks.** The sensors listed below are to be checked for calibration and adequate location.

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Location OK</th>
<th>BAS Value</th>
<th>Measured Value</th>
<th>Pass Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside air temperature</td>
<td>Y / N</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Space temperature</td>
<td>Y / N</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>RAT - avg.</td>
<td>Y / N</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
</tbody>
</table>

7 Sensor location is appropriate and away from causes of erratic operation.

**Comments:**

4. **Device Calibration Checks.** The actuators or devices listed below are to be checked for proper operation and/or calibration.

<table>
<thead>
<tr>
<th>Device or Actuator</th>
<th>Procedure / State</th>
<th>BAS Value</th>
<th>Site Observation</th>
<th>Pass Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside air damper / actuator</td>
<td>1. Observe OA damper modulating in unison with RA and EA damper.</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Exhaust air damper / actuator</td>
<td>1. Observe EA damper modulating in unison with RA and OA damper.</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Exhaust air fan status</td>
<td>Stop</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td>Start</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Device or Actuator</td>
<td>Procedure / State</td>
<td>BAS Value</td>
<td>Site Observation</td>
<td>Pass Y/N</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------</td>
<td>-----------------</td>
<td>----------</td>
</tr>
<tr>
<td>Outside air damper / actuator</td>
<td>1. Observe OA damper modulating in unison with RA and EA damper.</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Exhaust air damper / actuator</td>
<td>1. Observe EA damper modulating in unison with RA and OA damper.</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Exhaust air fan status</td>
<td></td>
<td>Stop</td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Start</td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Return air damper / actuator</td>
<td>1. Observe during outside air damper testing. Return air damper should operate inversely with the outside air damper.</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Supply air fan and status</td>
<td>1. Stop / Status</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td>2. Start / Status</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Electric Duct Heat</td>
<td>1. Off</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td>2. On</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Heat Recovery Wheel</td>
<td>Stop</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td>Start</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>H/C Valve</td>
<td>Fail Position</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td>50 % Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td></td>
<td>100 % Open</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
<tr>
<td>Low Limit Switch</td>
<td>Trip</td>
<td></td>
<td></td>
<td>Y / N</td>
</tr>
</tbody>
</table>

5. Notes
### 6. Functional Testing Record

<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The table continues with more rows that are not shown in this extract.
### Test Procedure

<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 1       | UNOCCUPIED MODE (Vacation Periods Only) | 1. Command the unit to the unoccupied mode through the BAS.  
2. When the unit is in the unoccupied mode command the unoccupied space temperature heating setpoint to 5°F above the current average space temperature.  
3. When the unit is in the unoccupied mode command the unoccupied space temperature heating setpoint to 5°F below the current average space temperature.  
Note: This may not be set up, as no sequence was provided. | 1. The outside air dampers will be closed. The return air damper will be open 100%. Observe fail position of DTW (HCV) valve. The heating unit will cycle to the unoccupied set point of 60deg (adj). The supply air fan will be off. This is the “shutdown” mode for the unit.  
2. The outside air dampers will remain closed. The return air damper will remain open. The supply air fan will be on. The heating module will start.  
3. The heating module will be de-energized. The supply air fan will stop. The unit will return to shutdown mode. | Y / N | Commissioning of HVAC Systems  
230800 - 12 |
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 3 | OCCUPIED MODE HEATING (SYSTEM INDEXED TO HEAT) | 1. Command the unit to occupied mode.  
2. When the unit is in the occupied mode adjust the space temperature heating setpoint to 5°F above the current space temperature.  
Note: If system is not indexed to heating mode DTW (HCV) valve will remain closed. | 1. The supply air fan will start. The outside, return and exhaust air dampers will modulate to maintain a minimum discharge air temperature setpoint of 53°F at sensor CLT. Heat wheel speed will control at this setpoint.  
2. The supply air fan will remain on line. The outside, return and exhaust air dampers will continue modulating. The DTW (HCV) will modulate to heat the space until the setpoint is satisfied. Discharge air temperature is limited to 55 to 80 Deg F. | Y / N |       |
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>AKF</td>
<td><strong>OCCUPIED MODE ECONOMIZER (COOLING MODE INDEXED)</strong></td>
<td>1. Note: May not apply not specified in sequence of operation. 2. When the unit is in the occupied mode override the outside air temperature to 48°F. Command the space temperature occupied cooling setpoint to 5°F above the current space temperature and the occupied heating setpoint to 5°F below the current space temperature. Command the mixed air temperature setpoint to 5°F below the current mixed air temperature.</td>
<td>1. The supply air fan will remain on. The outside, return and exhaust air dampers will modulate to provide more outside air, in a direct action control algorithm, to maintain the mixed air temperature setpoint of 55 degrees. If the cooling setpoint is not met then the DWT (HCV) valve will modulate open to meet space setpoint. 2. The supply air fan will remain on. The outside, return and relief air dampers will modulate to provide less outside air, in a direct action control algorithm, to maintain the mixed air temperature setpoint.</td>
<td>Y/N</td>
</tr>
<tr>
<td>Seq. ID</td>
<td>Mode ID</td>
<td>Test Procedure (including special conditions)</td>
<td>Expected Response</td>
<td>Pass Y/N</td>
<td>Notes</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td>-----------------------------------------------</td>
<td>-------------------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td>5</td>
<td>HEAT RECOVERY MODE</td>
<td>1. Normal operation</td>
<td>1. The heat recovery wheel is rotating with the exhaust air passing thru the wheel and the OA passing thru the wheel to warm air or cool air. No air is bypassing wheel</td>
<td>Y / N</td>
<td></td>
</tr>
</tbody>
</table>
| 6      | OCCUPIED DEHUMIDIFICATION (COOLING MODE INDEXED ONLY) | 1. With system indexed to cooling and the system is in occupied mode lower space humidity setpoint (62%) 10% lower.  
2. Return to normal. | 1. DTW (HCV) will modulate and electric heater will stage on and off to maintain space setpoint. This is the only function of the electric heater.  
2. DTW valve will return to normal control and the electric heater will stage off. | Y / N |       |
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 7.     | OCCUPIED COOLING (COOLING MODE INDEXED) | 1. With the system in occupied mode, lower space temperature setpoint (75) as sensed by TR, 5 Deg F. lower than current space temperature.  
2. Return to normal.                                                                                       | 1. The heat wheel increase speed to shed return air heat and the DWT (HCV) valve will modulate open to maintain new space setpoint. DAT shall never drop below 55 Deg. F. Allow time for control to stabilize.                                                                                                                   | Y / N    |       |
| 8.     | FROST CONTROL            | 1. With the unit running, raise the frost control setpoint as sensed at TF, 5 Deg F higher than current exhaust air temperature.  
2. Reset alarm time delay for exhaust air temperature to 2 minutes.  
3. Return all to normal.                                                                                     | 1. Observe heat wheel slow to raise exhaust air temperature to high setpoint.  
2. Observe low exhaust air alarm at BAS.                                                                                                                                | Y / N    |       |
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>FREEZE STAT ALARM AND SHUTDOWN</td>
<td>1. With the unit running in the occupied mode, trip the low limit thermostat located upstream of the HC coil.</td>
<td>1. The unit will shut down, and all dampers will go to their fail state, and DTW (HCV) valve will fail open to the coil. The BAS will indicate a freeze alarm.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Manually reset the freeze alarm at the BAS.</td>
<td>2. The unit will start in occupied mode.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>DIRTY AIR FILTER ALARM</td>
<td>1. With the unit operating, decrease the dirty filter alarm delay time to 2 minutes, and then gently pump up the high side of the filter DP.</td>
<td>1. Check that the BAS alarms.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Return to normal.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SUPPLY AIR FAN ALARM AND SHUTDOWN</td>
<td>1. With the unit running in the occupied mode, stop the supply air fan by turning it off at its starter.</td>
<td>1. The unit will go to its shutdown mode. The BAS will indicate a supply air fan status alarm.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Seq. ID</td>
<td>Mode ID</td>
<td>Test Procedure (including special conditions)</td>
<td>Expected Response</td>
<td>Pass Y/N</td>
<td>Notes</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td>9</td>
<td>EXHAUST FAN SHUTDOWN</td>
<td>1. With the unit running in the occupied mode, stop the exhaust fan by turning it off at its starter.</td>
<td>1. The unit will go to its shutdown mode. The BAS will indicate an exhaust fan status alarm.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>TRENDS</td>
<td>Set the following points for 15 minute trend samples and review in 48 hours:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Space temperature.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Supply air fan status.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Exhaust air fan status.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Outside air temperature.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Mixed air damper position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Room Humidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Supply Air Temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- END OF TEST -

END OF SECTION 230800
COMMISSIONING OF ELECTRICAL
SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:
   1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
   2. Division 23 HVAC
   3. Division 26 Electrical

1.3 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.

D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
E. Official: State or Local official having jurisdiction over the conveying systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
   1. Cabling and wiring
   2. Main distribution panel
   3. Switchboards
   4. Panelboards
   5. Grounding
   6. Lighting Control Devices
   7. Lighting
   8. Emergency lighting
   9. Emergency Generator
   10. Photovoltaic System

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
   1. The system or assembly is completely installed and functional
   2. Work performed by other trades, but essential for this system or assembly’s operation, is complete (e.g., electrical components are wired and power is provided)
   3. All contractor-performed start-up procedures and tests are complete.
   4. The system or assembly is ready for the Owner to take beneficial use.
3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
   1. Main distribution panel
   2. Feeders
   3. Panelboards and switchboards
   4. Branch circuitry
   5. Lighting controls
   6. Emergency lighting
   7. Grounding
   8. Emergency Generator
   9. Emergency Power System
   10. Photovoltaic System

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
   2. Division 26 Electrical

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS
Installation Checklist
Panelboards

Complete for each Panelboard
Panelboard ID# from drawings:
Reference Specification: 26000

Model Verification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Eaton-Cutler Hammer, General Electric, Square D Co., Siemens</td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Installation Checks

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Pass</th>
<th>Fail</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Panelboards have hinged front cover, entire front trim hinged to box and standard door within hinged trim cover.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Directory card with transparent protective cover mounted inside panel door.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Panelboards shown with a neutral shall have a full size insulated neutral bar installed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Panelboards shall have Bolt on Circuit breakers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Distribution panelboards shall have main circuit breakers; breakers larger than 600 amps shall be bolt on and shall be microprocessor based with true RMS sensing trip units.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Panelboards is installed such that the highest breaker handle is not more that 6’6” AFF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Typewritten directory of panelboard loads including circuit number, equipment served, and room number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Panelboard identification with plastic laminated nameplate (white with black lettering) mounted to panel with screws. Nametag to indicate panel name, amperage, voltage, phase and panel fed from.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Verify equipment is clean and free from damage</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10. Verify Panelboard is size and voltage as specified in contract documents, including breaker quantities and sizes.

11. Verify panelboard is installed to provide all working space requirements and clearances per NEC and local codes.

12. Verify that no piping, ductwork, or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to the panel and extending additional 6” on either side.

13. Panelboards that are part of the emergency distribution system is installed in space fully protected by an approved automatic fire suppression system or installed in space with a (1) one hour fire rating.

<table>
<thead>
<tr>
<th>Approvals (only one required)</th>
<th>Name (printed neatly)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer Representative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Administrator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning Agent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sample Functional Performance Test

Switchboard MDP

1. Participants

<table>
<thead>
<tr>
<th>Name/Representing</th>
<th>Participation (Testing, Witness, etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Party filling out this form _____  Date of test _____

2. Prerequisite Checklist

(Y/N) Factory testing results by the switchboard manufacturer have been provided for testing the ground fault protection system for circuit testing and verification of the tripping of the ground fault relays and also include polarity verification of the interconnection of the ground fault sensor circuits.

(Y/N) Field test reports have been provided for switchboard start up and testing and includes test procedure used and test results that comply with testing requirements. Included with the electrical contractors field start up and installation testing for the switchboard verify the ground fault protection system has been field tested and the test result have been provided.

(Y/N) A short circuit and protection coordination study has been provided and the switchboard protective relays and breakers settings have been adjusted per the study recommendations.

(Y/N) The electrical contractor has certified that their internal commissioning is complete and the project is ready for third-party verification.  EC initials:  _____  Date:  _____

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification.  GC initials:  _____  Date:  _____

5. Notes

6. Functional Testing Record:

Perform a visual verification of installed Switchboard #  MDP

<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Location</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
</table>

AKF

Commissioning of Electrical Systems
260800 - 6
<table>
<thead>
<tr>
<th>Seq. ID</th>
<th>Switchboard Location</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Verify switchboard is installed on 4” concrete pad.)</td>
<td>Concrete curb installed</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Verify operation of digital metering monitor: view the following: 1. Phase currents (each phase) 2. Ph-PH voltages (3ph) 3. Ph-Neutral voltages (3ph) 4. Frequency</td>
<td>All values indicated on monitor display screen.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Verify Switchboard identifications, all switchboard compartments to have nameplate identifications.</td>
<td>Nameplates installed</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Operate selective circuit breakers and verify correct operations</td>
<td>Circuits breaker operated open/closed</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Verify circuit breaker with adjustable trip units are adjusted per the coordination study results (compare with study results)</td>
<td>Circuit breaker trip units match study.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Verify switchboard is installed with quantity and sizes of breakers as indicated in the contract documents.</td>
<td>Circuit breakers installed per design.</td>
<td>Y / N</td>
<td></td>
</tr>
</tbody>
</table>

-- END OF TEST --
END OF SECTION 260800
SECTION 270800 - COMMISSIONING OF COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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   2. Division 23 HVAC
   3. Division 26 Electrical
   4. Division 27 Communications

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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
   1. Data / Wi-Fi system cabling and equipment
   2. Telephone system cabling and equipment
   3. CATV system cabling and equipment

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
   1. The system or assembly is completely installed and functional
   2. Work performed by other trades, but essential for this system or assembly’s operation, is complete (e.g., electrical components are wired and power is provided)
   3. All contractor-performed start-up procedures and tests are complete.
   4. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
   1. Data / Wi-Fi system
2. Telephone system
3. CATV system

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
2. Division 26 Electrical

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS

### SAMPLE Installation Checklist

<table>
<thead>
<tr>
<th>Construction Standards</th>
<th>Reference Specification</th>
<th>Reference Drawing</th>
<th>Area</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC</td>
<td>26 1000 2.13 &amp; 3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Installation Checks</th>
<th>Pass</th>
<th>Fail</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify all cables are as specified.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID 2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify all cabling is installed parallel and perpendicular to structural members and installed in a neat and workmanlike manner.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID 3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify sleeves are installed for electrical penetrations.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID 4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cables penetrating fire rated elements to be installed with sleeves and sealed with firestop.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID 5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect exposed sections of cables for physical damage.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Verify that branch circuit conductors are identified in each outlet box.

7. Where wires or cables are allowed to be installed without conduit verify that they are independently supported from the building structure. (cables and wires are not to be supported from ductwork, pipes, conduits or hung ceiling supports)

8. Verify cables installed in plenum ceilings are plenum rated.

9. 

10. 

Approvals (only one required)

<table>
<thead>
<tr>
<th>Name (printed neatly)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Manager or GC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Contractor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION 270800
COMMISSIONING OF ELECTRICAL SAFETY AND SECURITY
SECTION 280800 - COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:
   1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
   2. Division 21 Fire Suppression
   3. Division 23 HVAC
   4. Division 26 Electrical

1.3 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.

E. Official: State or Local official having jurisdiction over the conveying systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
   1. Fire Alarm

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
   1. The system or assembly is completely installed and functional
   2. Work performed by other trades, but essential for this system or assembly’s operation, is complete (e.g., electrical components are wired and power is provided)
   3. All contractor-performed start-up procedures and tests are complete.
   4. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
1. **Fire Alarm System**

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
   2. Division 21 Fire Suppression
   3. Division 23 HVAC
   4. Division 26 Electrical

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 **TEST REPORTS**

A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 **SAMPLE FORMS**
### Installation Checklist

**Fire Alarm**

Reference Specification: 16721
Reference Drawing: E001, E528 and power plans

#### Model Verification

<table>
<thead>
<tr>
<th></th>
<th>Specified</th>
<th>Submitted</th>
<th>Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Edwards, Notifier, Siemens Cerberus, Pyrotronics, Simplex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Installation Checks

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
<th>Pass</th>
<th>Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verify fire alarm components are installed per the contract documents; see drawings for device locations and drawing E001 installation height requirements. for each type of device.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fire alarm control panel FACP installed in room #429 with : (16721-2.10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Alphanumeric display</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Lockable steel surface mounted enclosure identified with Red nameplate not to exceed 72&quot; mounting height.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. local Visual and audible signals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Firefighters telephone control module</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. manual switching functions including Acknowledge, silence, test, and reset functions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fire Alarm annunciator panel installed in corridor #426 with : (16721-2.11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Duplicate annunciator and control functions of the FACP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Alphanumeric display</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Surface mounted</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Approvals (only one required)

<table>
<thead>
<tr>
<th>Name (printed neatly)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer Representative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Administrator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning Agent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Table of Approvals

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Manual pull stations:</td>
<td>Semi Flush, recessed back boxes, Red plastic or metal box with raised letter operating instructions, and a key or wrench station reset feature. (16721-2.3)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Smoke Detectors – plug-in arrangement with integral visual indicating light (16721-2.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Heat Detectors – plug-in base, interchangeable with smoke detector base (16721-2.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Notification appliances, visual devices with clear or nominal white polycarbonate lens with FIRE engraved on lens (16721-2.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Firefighters Telephones with handsets, high impact plastic coil cord and hook switch, located at: (16721-2.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Each elevator car</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Each elevator lobby</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Inside each stairwell at each floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Fire pump room</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Each elevator machine room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>All fire alarm wiring to be installed in metal raceway (16721-3.2-A)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>All fire alarm wiring to be color coded alarm supervisory, and alarm initiating wiring to be different color code from building wiring and from each other. (16721-3.2-D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>All fire alarm system junction box covers to be painted RED. (16721-3.2-D)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Functional Performance Test

Fire Alarm

1. Participants

<table>
<thead>
<tr>
<th>Name/Representing</th>
<th>Participation (Testing, Witness, etc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Party filling out this form _____  Date of test _____

2. Prerequisite Checklist

(Y/N) A completed report of installation inspection, adjusting and settings for the Fire Alarm System by factory authorized service representative has been provided. Including the following written report/tests as outlined in specifications section 16725-3.5.

1. Fire Alarm has been testing according to the procedures outlines in NFPA 72.

2. Absence on unwanted voltages between circuit conductors and ground.

3. Test all conductors for short circuits

4. Test each initiating and indicating device for alarm operation and response at the control unit. Test smoke detectors using the walk test.

5. Test the system for all specified functions according to the approved operation and maintenance manual. Initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communication options. For each item observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.

(Y/N) The Owners representative and building occupants have been notified.

(Y/N) The Fire Department/fire officials (AHJ) have been notified.

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: __ __. Date: __ __.

(Y/N) Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc., that were changed to accommodate testing:
4. Functional Testing Record

<table>
<thead>
<tr>
<th>Seq . ID</th>
<th>Mode ID</th>
<th>Test Procedure (including special conditions)</th>
<th>Expected Response</th>
<th>Pass Y/N</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PREPERATION</td>
<td>1. Notify the local authority that there will be testing of the fire alarm system and that the system will be off-line until further notice.</td>
<td>1. Alarms that are activated will not notify the local authorities.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Seq ID</td>
<td>Mode ID</td>
<td>Test Procedure (including special conditions)</td>
<td>Expected Response</td>
<td>Pass Y/N</td>
<td>Notes</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>2</td>
<td>ACTIVATION</td>
<td>1. De-activate the notification circuit. Actuate 25% of devices, either with Pull station, smoke, or a magnet. Activation of initiating device causes the following to occur: (See below for list of initiating device activations)</td>
<td>1. The device will activate the alarm system and the location on the screen will be detailed enough to provide an exact location of the alarmed device.</td>
<td>Y/N</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NOTIFICATION</td>
<td>1. Activate a device. When the alarm is issued, inspect the horn strobes to make sure that all are sounding and that the lights are synchronized.</td>
<td>1. All of the notifications will be synchronized.</td>
<td>Y/N</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>FACP power supply check</td>
<td>1. Simulate a Loss of primary power to FACP.</td>
<td>1. FACP will switch to secondary power supply and a trouble signal will be sent to FACP and remote annunciator. A “on emergency power” light should be illuminate at both locations.                                                                 /**&lt;javascript*/;return true; $/247</td>
<td>Y/N</td>
<td></td>
</tr>
<tr>
<td>Seq ID</td>
<td>Mode ID</td>
<td>Test Procedure (including special conditions)</td>
<td>Expected Response</td>
<td>Pass Y/N</td>
<td>Notes</td>
</tr>
<tr>
<td>--------</td>
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<td>-----------------------------------------------</td>
<td>-------------------</td>
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<td>-------</td>
</tr>
<tr>
<td>5</td>
<td>Duct Smoke detectors</td>
<td>1. Simulate/activate duct smoke detector.</td>
<td>1. Alarm signal sent to FACP and supply and return fans of appropriate AHU will shut down.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Elevator Recall</td>
<td>1. Operate/activate smoke//low temp heat detector in elevator shaft. 2. Operate /activate high temp heat detector</td>
<td>1. Elevator recall is activated 2. Shunt trip circuit is activate to shut down power to the elevator.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sprinkler Valve tamper Switch</td>
<td>1. Activate sprinkler tamper switch.</td>
<td>1. A supervisory audible and visible “Valve Tamper” signal is indicated at the FACP and remote annunciator. The System records event and prints record.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Fire Pump monitoring</td>
<td>1. Simulate operation or alarm condition at fire pump: pump running. Loss of phase, phase reversal, controller connected to alt source, loss of water.</td>
<td>1. FACP and remote annunciator receive a supervisory audible and visible signal. System records event and prints record.</td>
<td>Y / N</td>
<td></td>
</tr>
<tr>
<td>Seq ID</td>
<td>Mode ID</td>
<td>Test Procedure (including special conditions)</td>
<td>Expected Response</td>
<td>Pass Y/N</td>
<td>Notes</td>
</tr>
<tr>
<td>-------</td>
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<td>---------------------------------------------</td>
<td>------------------</td>
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<td>-------</td>
</tr>
<tr>
<td>9</td>
<td>Initiating device removal</td>
<td>1. Manually remove alarm-initiating devices.</td>
<td>1. A “trouble” signal indication at the FACP and Remote annunciator for the device or zone involved.</td>
<td>Y/N</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>FACP Instruction card</td>
<td>1. Verify Printed instruction card which includes a description of appropriate response from display and signals, and brief descriptions of the functional operations of the system under normal, alarm, and trouble conditions.</td>
<td>1. Instruction card is present.</td>
<td>Y/N</td>
<td></td>
</tr>
</tbody>
</table>
| 11    | AHJ NOTIFICATION | 1. Restore the system to normal operation. Notify the AHJ that there will be a test of the alarm system and request that they stay on the line and state when the alarm comes in to them and repeat the message.  
2. Activate a device and record the time from activation to AHJ notification. | 1. The AHJ should be notified within 10 seconds of the original alarm. | Y/N     |       |
* Operation of an initiating device shall cause the following to occur:

1. Audio Visual notification devices will activate (devices will be synchronized)
2. FACP and Remote annunciator panel will receive ID of initiating device in alarm.
3. Remote annunciator panel receives an alarm.
4. Unlocking of electric door locks in designated egress paths.
5. Release of magnetic door holders to close fire and smoke doors.
6. Elevator recall only on activation of smoke or heat detector in associated elevator shaft, machine room, or lobby.
7. Smoke dampers close in ducts serving area in alarm.
8. Event recorded in memory
9. Send alarm signal to local fire department.

END OF SECTION 280800
7. Appendix
APPENDIX

TABLE OF CONTENTS
TABLE OF CONTENTS
APPENDIX

SECTION TITLE

BUILDING CHECKLIST
NYPH ENERGY STANDARD
   ENERGY COMPLIANCE GUIDELINES
   ENERGY CONSERVATION GUIDELINES
   NYPH PROJECT REVIEW PROCESS
   EQUIPMENT EFFICIENCY STANDARDS
   NYSERDA PROCESS DOCUMENT & APPLICATION FORM
   ASHRAE - ADVANCE ENERGY DESIGN GUIDE FOR LARGE HEALTHCARE INSTITUTIONS

ENGINEERING CHECKLIST

CAD STANDARDS
ELECTRICAL SIGNOFF FORMS
NYPH EQUIPMENT AND DEVICES LABELING
AHU ACCEPTANCE FORM
EQUIPMENT CUTS
BUILDING UTILITY REQUEST CHECKLIST
1. INTRODUCTION

a. During the schematic Phase an estimate of the required MEP/FP system capacities including chilled water, steam, hot water (heating and reheat), electrical (normal and emergency), medical gases, hot and cold water and other major infrastructure utilities shall be provided utilizing the building utility request checklist.

a) The estimated load requirements shall be issued and reviewed by NYPH PM, OFD, MCE and OFO.

b) The design engineer and NYPH-OFO shall fill out a Building Utility Request Checklist and provide an MEP/FP narrative.

c) NYPH-OFO shall advise if the existing infrastructure can accommodate the requested load required for any partial floor renovation.

d) A meeting shall be scheduled by the NYPH PM with the Engineer, NYPH-OFO and OFD to review any existing infrastructure limitations and to determine what infrastructure upgrades are required to accommodate the proposed renovation.

e) If infrastructure upgrades/improvements are required to accommodate a proposed partial floor renovation NYPH-OFO will coordinate the individual project requirements with any future capital improvement and or maintenance projects.

f) The NYPH PM, OFO and OFD shall coordinate and determine the source of the additional capital required to provide any infrastructure upgrades.

g) The design engineer and/or architect shall coordinate submission of any required additional services due to infrastructure upgrades not included in the base contract with the NYPH PM, OFO and/or OFD.

h) Design engineer shall re-submit a revised Building Utility Request Checklist if there is a change in project scope that affects utility requirements.

i) Final Building Utility Request Checklist with all appropriate sign offs shall be submitted for record with the 100% Construction Documents.
### BUILDING UTILITY REQUEST

**Project Name:**
**NYPH Project #:**
**Building:**
**Floor:**
**Architect:**
**MEP/FP Engineer:**

**HVAC**

### 1. COOLING SYSTEMS

**A. Chilled Water System:**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Exiting Capacity (tons):</td>
<td>Response</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Existing GPM:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Required Capacity (tons):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Required GPM:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Water Temperatures:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Riser/Main Location:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Riser Size:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>24/7 Operation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**B. Condenser Water System:**

<p>| | | | |</p>
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<thead>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Existing Capacity (tons):</td>
<td>Response</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Existing GPM:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Required Capacity (tons):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Required GPM (tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Water Temperatures:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Riser/Main Location:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Riser Size:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>24/7 Operation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**C. Air Systems:**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type (i.e., DX, VAV, constant volume with reheat etc.):</td>
<td>Response</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AHU Location:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Existing Capacity (CFM):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Required Capacity (CFM):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Floors served and zones:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Discharge Supply Air Temperature:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2. HEATING SYSTEMS:
### A. Steam:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Source:</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Type: (HP/MP/LP)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Riser Locations:</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Existing Capacity:</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Required Capacity:</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Pressure:</td>
<td></td>
</tr>
</tbody>
</table>

### B. Hot Water:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Source:</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Type: (Reheat/Perimeter)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Location:</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Riser Location:</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Water Temperatures:</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Existing GPM:</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Required Capacity: (MBH)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Required GPM:</td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL

#### 1. Electric Services:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Type (conduit, bus duct or combination, cable: copper, aluminum):</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Voltage:</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Riser Location:</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Existing Power Capacity (watts/sq. ft.):</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Required Power For Renovation:</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Age and general condition of equipment:</td>
<td></td>
</tr>
</tbody>
</table>

#### 2. Electric Closets:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Number and size per floor:</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Space availability:</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Panel Boards (circuit breaker/fuses):</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Does Renovation require new panels?</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Age and general condition of existing equipment:</td>
<td></td>
</tr>
</tbody>
</table>
## 3. Emergency Power System:

<table>
<thead>
<tr>
<th>A. Type:</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Location:</td>
<td>Response</td>
</tr>
<tr>
<td>C. Existing Capacity:</td>
<td>Response</td>
</tr>
<tr>
<td>D. Required Capacity for renovation:</td>
<td>Response</td>
</tr>
<tr>
<td>E. Age and general condition of equipment:</td>
<td>Response</td>
</tr>
</tbody>
</table>

## PLUMBING

### 1. Domestic Water Services:

| A. Number and size of services: | Response |
| B. Backflow preventers: | Response |
| 1) Location: | Response |
| 2) Clearances: | Response |

### 2. Water Supply System:

| A. Street pressure, house tank or booster pump system: | Response |
| 1) Constant or seasonal drop in incoming pressure. | Response |
| B. Building provided with a suction tank (booster pump system): | Response |
| C. Location of house tank(s): | Response |
| D. Riser Locations: | Response |
| E. Domestic water reserve in house tank(s) (number of gallons): | Response |
| F. Number and capacity of house pumps (house tank system or booster pumps): | Response |
| 1) Redundancy: | Response |
| G. Number of zones (floors served per zone): | Response |
| H. Existing Pipe condition | Response |

### 3. Domestic Hot Water:

| A. Availability (capacity and temperature): | Response |
| B. Number of zones and maximum pressures: | Response |
| C. Hot water circulation: | Response |

### 4. Sanitary and Venting System:

| A. Size and location of sanitary discharge: | Response |
| B. Pipe material: | Response |
| 1) Originally provided: | Response |
| 2) Later modifications: | Response |
### New York Presbyterian Hospital
### Engineering Design Standards
### March, 2015

### Building Utility Request Checklist

#### 5. Wet Columns:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Number per floor:</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Services (sanitary, vent, hot and cold water):</td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>Size of capped outlets:</td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>Invert of sanitary or waste outlet:</td>
<td></td>
</tr>
</tbody>
</table>

#### 6. Plumbing Fixtures:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Existing Number and type of fixtures per floor:</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Renovation Required Number and type of Fixtures per floor:</td>
<td></td>
</tr>
</tbody>
</table>

### FIRE PROTECTION SYSTEMS

#### 1. Automatic Sprinkler Protection:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>None, Full or Partial Sprinklers throughout:</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Existing Space:</td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td>Renovated Space:</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Specialty systems:</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Dry pipe, pre-action, etc.:</td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>Sprinkler Valve Assemblies per Floor:</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Number:</td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td>Location:</td>
<td></td>
</tr>
<tr>
<td>3)</td>
<td>Size:</td>
<td></td>
</tr>
<tr>
<td>4)</td>
<td>Water flow and tamper switch connected to fire alarm system:</td>
<td></td>
</tr>
<tr>
<td>5)</td>
<td>Height of assemblies above floor:</td>
<td></td>
</tr>
</tbody>
</table>

#### 2. Building Supply:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>House tanks:</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Fire reserve (number of gallons)</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Fire pump(s):</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Location:</td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td>Capacity:</td>
<td></td>
</tr>
<tr>
<td>3)</td>
<td>Manual/automatic:</td>
<td></td>
</tr>
</tbody>
</table>

#### 3. Fire Standpipe Systems:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Type (combined or separate):</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>Class I, II or III:</td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>Number of zones and floors served per</td>
<td></td>
</tr>
<tr>
<td>zone:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>D. Number of risers per floor:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Top of standpipe design pressure:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MEDICAL GASES**

1. **Building Supply:**
   - A. Type of Gases (Air, Vacuum, Nitrogen, Oxygen)
   - B. Local or Central System:
   - C. Area Valve Box Location:
   - D. Alarm Panel Location:

2. **Local System:**
   - A. Existing Tank Capacity:
   - B. Required Tank Capacity:
   - C. Tank Location:
   - D. Space available for expansion:

3. **Central System:**
   - A. Location:
   - B. Number of Risers:
   - C. Size of pipe main and/or riser:
   - D. Available Capacity:
   - E. Location:

4. **Medical Valve Outlets:**
   - A. Existing Number and type of fixtures per floor:
   - B. Required Outlet Number:
   - C. Number of Valve Boxes:
   - D. Required Valve Boxes:
   - E. Alarm Panel Requirements:
Required Sign Off:

___________________________________             ____________
OFO Representative                                    Date

___________________________________             ____________
Master Campus Engineer                                 Date

___________________________________             ____________
Campus Cx Agent                                        Date

___________________________________             ____________
NYPH PM                                                Date

___________________________________             ____________
Architect                                              Date

___________________________________             ____________
MEP/FP Engineer                                        Date
ENERGY COMPLIANCE GUIDELINES
ENERGY COMPLIANCE GUIDELINES

CURRENT ENERGY CODES:
The current energy code for NYC is: 2014 NYCECC

**To comply with this code, you may design to either: ASHRAE 90.1-2010 Or [New York City Energy Conservation Construction Code (NYCECC)-2014 Chapter 4/5
And also:

- All applicable local laws, rules, and bulletins:
  - 1 RCNY §5000-01: Defines submission procedures and requirements for progress inspections.
  - 1 RCNY §101-07: Progress inspection responsibilities.
  - Bulletin 2010-031: Where HVAC or service hot water system may not be required to comply.
  - Bulletin 2010-032: Where lighting, power, or control systems may not be required to comply.
  - Bulletin 2011-015: Where building envelope may not be required to comply.

REQUIREMENTS FOR DESIGNER/ENGINEERS

**To document your compliance on design drawings:

- EN-100: Use 1 of the 3 methods below
  - <Simple Project> Create and edit a prescriptive table (example prescriptive table)
  - <Standard Project> Create a ComCheck Report
  - <Complex Project> Create an energy model (usually for large LEED projects, expensive)

AND...

- EN-200: TR8 Inspection tables (example TR8). Edit Checklist and list the applicable drawings for each item falling under the Energy scope.

These documents must be included in the initial filed drawings in an Energy Series (EN-100, EN-200, etc.). The EN-200 is a new requirement that we must begin to follow in order to avoid audits and slow downs in filing and progress inspections.

Every project (new construction, renovation, alteration & repair) must have these filed documents, even if there are no energy related items in the scope of work. If that is the case, or if there are EXCEPTIONS or ALTERNATES for special circumstances as defined in the Code, you must still show the documentation and site the EXCEPTION or ALTERNATE. (example: medical procedure room lights)
The only project types that are EXEMPT from the Code are National or State Historic Buildings and unconditioned or temporary structures. The only work types that are EXEMPT from the Code are: FA, FP, SD, SP, FS, EQ, CC, OT/BPP, OT/FPP. No need to file EN- drawings if the project consists of only these trades.

THE DOB IS STARTING TO ISSUE OBJECTIONS FOR JOBS THAT DO NOT ISSUE AN EN- SERIES DRAWING WITH THE PROPER DOCUMENTATION REGARDING THE ENERGY CODE!

**CLARIFICATIONS:**
- Documentation of code compliance must be provided with initial filing.
- Residential buildings over 3 stories are really considered Commercial buildings for the Energy Code.
- All trades (envelope, mechanical, service water heating, power & lighting) must demonstrate compliance with the same choice (ASHRAE or NYCECC).
- Some code-mandated metrics are mandatory and can be demonstrated prescriptively. Some code-mandated metrics can be demonstrated using trade-offs in ComCheck (envelope only). All other trade-offs must be done in energy models only.

**NEW YORK CITY RESOURCES:**

These links have the detailed information of the Code and what you need to be aware of for specific trades and systems.

Main Site (links at the bottom of the page):

Administrative Module:

Residential Module:

Commercial Envelope Module:

Commercial HVAC-1 Module:
New York Presbyterian Hospital
Engineering Design Standards
March, 2015

Commercial HVAC-2 Module:

Commercial Lighting Module:

NYC Greener, Greater Buildings Plan:

Local Law 87:

END OF SECTION

NYPH ENERGY CONSERVATION GUIDELINES
TITLE: ENERGY CONSERVATION GUIDELINES

INTRODUCTION:

New York-Presbyterian’s corporate energy policy describes core values and responsibilities for implementing the energy management program. Energy conservation and sourcing will be achieved in concert with NYP’s environmental mission statement to create the safest and healthiest environment for patients, staff and community. This Energy Policy applies across the five main campuses: The Allen Hospital (AH), Columbia University Medical Center (CUMC), Weill Cornell Medical Center (WCMC), and Westchester Division (WD), New York Lower Manhattan (NYLM) and Royal Charter Properties.

New York Presbyterian Hospital’s vision is to be among the top academic medical centers in the nation in clinical and service excellence, patient safety, research and education. Our Strategic Initiatives provide the roadmap to guide us in achieving this vision. They identify the primary areas on which we need to focus so that we can realize our goals and continue to do the very best for our patients and their families at all times. Our Strategic Initiatives support our ultimate goal: “We Put Patients First.” This means that in everything we do, we must make patients our first priority and strive to provide them with the highest quality, safest, and most compassionate care and service.

We are focused on delivering world class Patient Outcomes, Patient Safety and Patient Experiences. We recognize that we are stewards of our environment and are responsible for being leaders in our use of resources because of our community health mission. We believe that proper management of resources can improve the Environment of Care and lead to positive impacts to Patient Outcomes, Patient Safety and Patient Experience.

We are an ENERGY STAR Partner who is committed to learning from and, where applicable, to teaching others to become better stewards. We believe that Energy Efficiency is the fastest, cheapest, and largest untapped solution for saving energy, saving money, and preventing greenhouse gas emissions that can have a negative impact on community health. We believe that ENERGY STAR tools and resources allow us to be better stewards and improve our efficiency in an integrated manner so that we are
able to focus our energy strategies on Putting Patients First, on improving community health, on our business imperatives and on our own caregivers.

PURPOSE:

The purpose of this energy policy is to establish the framework for acceptable protocols, practices and operational standards. The goal of this energy policy is to fully integrate with our Strategic Initiatives to further foster a culture of engagement by positively impacting the environment of care throughout its entire lifecycle. New York-Presbyterian’s commitment to energy conservation begins with a vision to be the most efficient energy steward in the healthcare industry.

1. Institutional Responsibility:

Natural resources consumed to create energy have intrinsic societal value. NYP commits to employ best practices to continuously reduce energy use as outlined by EPA’s ENERGY STAR Guidelines to Energy Management. Further, NYP seeks innovation, including the use of renewable sources, to use and supply energy in a manner that protects the environment and conserves natural resources.

2. Employee Expectations:

NYP shall maintain a comfortable environment for patients, staff and community. In return, NYP holds employees responsible for conserving energy in all aspects of their work. Examples include: turning off computers, monitors and lights when not in use; utilizing virtual meetings when appropriate; avoiding use of personal space heaters and fans; and properly managing Hospital equipment to minimize energy use. To achieve these goals, NYP will prepare, review and implement understandable and practical energy use guidelines.

3. Building Energy:

NYP seeks to further reduce energy costs and increase efficiency in new construction and renovation, as well as improving existing building operations, whenever feasible. New York-Presbyterian’s various departments will collaborate to develop an integrated strategy to optimize energy supply and demand efficiency. The benefits resulting from energy optimization are both financial, including reduced operating costs, and non-financial,
including emissions reduction, minimization of waste and improved corporate
citizenship. New building construction and renovations shall fully comply with
the latest guidelines and standards of the “American Society of Heating, Refrigration and Air Conditioning Engineers” (ASHRAE) and the
“Illuminating Engineering Society” (IES) Standard 90.1, which identify the
basic energy efficiency requirements for building envelope, HVAC (heating
ventilation and air conditioning) systems and Hot Water systems. Adherence
to this standard will ensure that energy efficient building systems are
implemented at NYP.

4. Procurement:

Through NYP’s HERCULES initiative, equipment replacement and materials
purchasing, NYP will promote reduced, efficient energy use and sustainable
practices. NYP commits to purchase energy efficient appliances, computers,
IT equipment, air conditioners, refrigerators, vending machines and other
electronics. Energy efficiency will be a standard criterion in all RFPs and
contracts. See the US EPA ENERGY STAR product lists:
http://www.energystar.gov/

5. Implementation and Administration:

The Office of Facilities Operations, Energy Programs and the Energy
Efficiency Committee will sponsor the objectives and values of this policy and
will establish enterprise-wide performance goals for reductions in energy use
and cost. Working with NYP senior management and NYPgreen
(Sustainability Council), these groups are responsible for, and will
coordinate, corporate-wide initiatives to achieve the objectives of this policy,
including developing an integrated strategy for optimization of energy supply
and demand efficiency. The Energy Program will publish energy procedures
and guidelines in support of this policy, establish energy use reduction goals,
and report NYP’s progress toward achieving those goals. All NYP divisions are
responsible for integrating the objectives and values of this policy into
business practices.
The Office of Facilities Operations, the Energy Management Team, and Sustainability Officer will cooperate to continue and enhance communication of energy issues. NYP will strive to expand and improve education and outreach to provide opportunities for NYP employees to participate in energy conservation and sustainable practices.

The active and regular participation of the entire NYP community is essential to the success of this corporate energy policy. Individual managers, key delegates, department heads, and/or business managers are encouraged to assume responsibility to achieve the goals of NYP’s energy policy specific to their respective units and areas.

**PROGRAM GOALS:**

1. Existing Buildings.
   
   A. Operational. All buildings where New York Presbyterian has a staff or patient presence shall:
      
      1) Be tracked in ENERGY STAR Portfolio Manager and PlaNYC.
      2) Be candidates for retro or continuous commissioning.
      3) Take advantage of Green Teams, Patient Safety Fridays, and other engagement events to identify opportunities for improvement.
      4) Strive for ISO 50001 compliance.
   
   B. Cultural. Our caregivers are our most important advantage. In recognition of this, our programs will be designed to:
      
      1) Engage our caregivers by demonstrating how our energy goals further our goal of always Putting Patients First.
      2) Giving our caregivers the tools necessary to identify and submit potential opportunities.
      3) Recognizing our Amazing People through celebrations of achievement.
4) Giving our caregivers tools and resources that will help them further their conservation goals and save money at home.

C. Metrics. We will report our Energy Usage Index on the Facilities Portal Energy Dashboard and individual ENERGY STAR scores to Senior Leadership on a monthly basis. http://facilities.nyp.org/FinanceOperations/Energy/default.aspx

2. Building and Space Renovation.
   A. Will identify opportunities to improve energy efficiency during the design phase.
   B. Will implement identified opportunities that meet program goals.
   C. Will commission energy efficiency projects that are implemented.

3. New Footprint Construction.
   A. Shall participate in the US EPA “Designed to Earn ENERGY STAR” and “Target Finder” programs including application filing at: www.energystar.gov.
   B. Shall exceed ASHRAE 90.1 by 10%.
   C. Shall take advantage of applicable strategies from the ASHRAE/DOE Advanced Energy Design Guides.
   D. Shall achieve a minimum of USGBC LEED Silver Certification in Healthcare.
   E. Shall identify opportunities to improve energy efficiency during the design phase.
   F. Shall implement identified opportunities that meet program goals.
   G. Shall not value engineer identified opportunities that meet program goals solely on the basis of initial cost.
PROGRAM STRATEGIES

1. All building envelope components shall meet or exceed the minimum requirements prescribed in ASHRAE 90.1.

   A. A cost proposal shall be submitted for achieving the applicable envelope component goal listed in the ASHRAE/DOE Advanced Energy Design Guide.

   B. The effectiveness of the building envelope shall be verified by thermal imaging and carbon dioxide monitoring.

2. Lighting power density shall not exceed the minimum levels prescribed in ASHRAE 90.1 and lumen levels shall meet IESNA RP 29-6. Please refer to NYP’s Lighting Guidelines.

   A. Down lights, spotlights and decorative lighting shall use an LED source from an approved vendor.

   B. Area lights shall use an F28T8, T5 or LED source from an approved vendor.

   C. High bay lights shall be approved on a case by case basis.

   D. Occupancy sensors and controls shall be incorporated.

3. Renewable Energy should be considered for all projects, this includes thin-film solar photovoltaic (PV), solar thermal, combined heat and power and wind. A life cycle cost analysis shall be performed for all new footprint projects that include first cost, potential grants/utility incentives, energy cost and maintenance/operational costs from both an ownership and power purchase agreement for third party ownership perspective.

4. Energy Modeling & Analysis: An energy analysis shall be submitted at the end of schematic design and design development and shall include the following:
A. Narrative describing ASHRAE Cost Budget Building assumptions including schedules for thermostats, people, lighting miscellaneous/plug loads and HVAC equipment.

B. Narrative describing energy conservation opportunities evaluated along with first cost impact and life cycle cost analysis.

C. Modeling archive file used to model energy consumption.

5. Commissioning will be required for all projects including projects not pursuing LEED.
   A. Develop a commissioning plan, as outlined LEED version 3.0 Energy and Atmosphere credits EA-pr1: Fundamental Building System Commissioning and EA –c3: Enhanced Commissioning.

   B. Commissioning is a systematic process ensuring all building systems perform interactively according to the design intent and the owner’s operational need.

   C. Commissioning during this construction of this project is intended to achieve the following objectives: Quality, Value, Comfort, Energy Efficiency, Serviceability and Sustainability.

   D. Refer to NYP’s Commissioning Plan

6. Retro-Commissioning will include identification of system operating, control, and maintenance issues; reduction of maintenance cost and equipment failures; reduction of energy cost and waste; documentation of building systems; training operating staff; and data for long term planning and maintenance budgeting.

   A. Level II ASHRAE Energy Audits shall be performed for all buildings on per NYC Local Law 87 requirements. Identified energy conservations measures will be evaluated and prioritized.

   B. Data from utilities meters and monitoring systems as well as from building automation systems shall be reviewed in order to identify and correct issues.
PROCEDURE:

1. Energy Savings Guidelines

   A. PURPOSE:

   These Guidelines will help NYP employees play a role in promoting efficient, reduced energy use.

   B. GUIDELINES:

   1) Where individual controls are available on HVAC units, the Office of Facilities Operations will set thermostats according to the table below. During the winter heating season, where individual occupants can control temperature settings, thermostats should be set at 70°F during the day and should be set back to 60°F before the end of each business day and through the weekend. During the summer cooling season, temperatures should be set at 75°F during the day, turned off at the end of each business day, and set at 85°F over the weekend.

   2) The Office of Facilities Operations will utilize the night setback features of the Building Management System (BMS) to set building heating season temperature to 60°F at night and on weekends, except in research facilities.

   3) The use of space heaters is NOT permitted in NYP facilities because they are grossly inefficient and may pose a significant fire hazard. (Refer to Fire Safety Policy) NYP employees who feel that their work environment is too cold should contact the Office of Facilities Operations. An exemption request will need to be submitted to the Office of Facilities Operations to evaluate conditioned space and approve or disapprove of radiant heater. Facilities Operations will need to review requests with NYP’s Environmental Health and Safety and Regulatory Compliance units to evaluate individual concerns.

   4) NYP employees are encouraged to engage in routine practices to reduce energy consumption. While administrative areas, laboratories, and other work areas must be adequately lit, lights that are not needed should be turned off. When rooms or buildings
are unoccupied, lights not needed for safety and security purposes should be turned off.

5) Computers and other equipment should be set on energy saving settings, such as “sleep mode” and should be ENERGY STAR rated.

6) Copiers that do not automatically turn off after a period of inactivity should be turned off at night and during the weekend.

7) All persons using research equipment that requires water for cooling and other similar purposes should minimize water use, as possible, and shut off the water supply when equipment is not in use.

8) The Office of Facilities Operations will work to reduce lighting levels in all corridors per New York City’s Energy Code. NYP will maintain adequate lighting for security and safety requirements and in line with NYP’s Lighting Guidelines.

9) Water leaks and dripping faucets should be reported immediately to the Office of Facilities Operations for prompt repair.

10) Windows should be firmly closed and locked to prevent leakage of conditioned air. Doors should be closed when rooms are not in use.

11) Employees are encouraged to contact the Office of Facilities Operations at WCMC (212) 746-1920, CUMC (212) 305-5175, TAH (212) 932-5032, WD (917) 997-5701 regarding temperature control problems, lighting, and/or water leaks.

12) Incandescent bulbs must be replaced with compact fluorescent light bulbs or equivalent LED sources.

13) All plug-in devices, including chargers for mobile phones, PDA’s and other devices, should be unplugged when not in use.

14) Be proactive and aware of energy waste. If you see energy inefficiencies around you, contact the Office of Facilities Operations or the Energy Program Manager to report the problem keb9039@nyp.org.
15) Help your colleagues to be energy efficient. Please visit the NYPGreen site on the Infonet, or speak to the Sustainability Officer or the ‘Green Champion’ in your unit. Obtain NYP’s Green Workspace Certification for your department/unit.

2. Building Operations Standards

A. GUIDELINES:

1) Interior lighting shall be specified and deployed per the fixture selections, energy efficiency ratings, and lamp types defined in NYP’s Lighting Guidelines. New energy saving fixtures, lamps and/or ballasts will be used to replace less efficient lighting whenever economically feasible. Lighting levels shall be designed and maintained per the Illuminating Engineering Society, 90.1 Standards.

2) Where feasible and cost effective, occupancy/motion sensors (ultrasonic/infrared) shall be installed to automatically reduce or turn off lights in unoccupied areas (i.e. administrative areas, individual offices, conference rooms, locker rooms, pantries, restrooms, etc.)

3) NYP shall establish energy efficiency standards for all IT equipment connected to NYP’s IT network and energy distribution systems.

4) The Office of Facilities Operations shall assure that all equipment operates at peak efficiency levels and complies with energy consumption benchmarking targets.

5) The Office of Facilities Operations shall prepare regular energy audits and/or assessments of all NYP facilities to identify building use, performance and condition; and to identify energy conservation opportunities and facility improvement measures.

6) The Office of Facilities Operations shall prioritize facility infrastructure maintenance, repair, retro-commissioning, re-balancing, renovation and/or renewal to meet applicable standards.
7) The Office of Facilities Operations shall continue to sub-meter all utilities from consumption to production to distribution. Sub-metering data shall be collected, stored and reported as a tool for identifying potential energy savings projects, and to provide verification of projected energy savings. The Office of Facilities Operations shall install and maintain a metering system and information technology backbone capable of automatic recording of interval data for each utility.

RESPONSIBILITY:

Vice-President, Facilities Operations
Manager, Energy Programs

REFERENCES:
Where referenced below unless noted otherwise, the latest versions of the following standards shall be followed:

e. USGBC Treatment of District or Campus Thermal Energy in LEED V2 and LEED 2009 – Design and Construction.
h. NYP’s Mechanical, Electrical, Plumbing Standards
i. NYP’s Lighting Guidelines
j. NYP’s Interior Guidelines

POLICY DATES:
 Issued: April 2013
NYPH PROJECT REVIEW PROCESS
NYPH PROJECT REVIEW PROCESS
EQUIPMENT EFFICIENCY STANDARDS

NYPH project equipment specifications require compliance with the following efficiency standards:

B. CEE Directory - www.creedirectory.org
C. ENERGY STAR listing – www.energystar.gov

END OF SECTION
NYSERDA PROCESS DOCUMENT & APPLICATION FORM
March 27, 2014

TO: Architects, Engineers, Construction Managers, Project Managers, Consultants and Vendors working with New York Presbyterian Hospital (NYPH)

Re: Procedure for New York State Energy Research and Development Authority (NYSERDA) Related Incentives for Projects Yielding Energy Efficiency

PROGRAM NARRATIVE:

New York Presbyterian Hospital (NYPH) is committed to significantly reducing its carbon footprint and energy usage. As part of this goal, NYPH is seeking incentives provided through NYSERDA’s Flex Tech, Existing Facilities and New Construction Programs for projects which reduce energy consumption.

BASIC NYSERDA REQUIREMENTS:

Architects, Engineers (A/E) and their consultants assigned to each project must work in conjunction with the Construction Managers (CMs), NYPH’s Project Managers (PMs) and NYPH’s Project Engineers to assist in streamlining the NYSERDA submission process. This includes the necessary scope of work to reflect the required NYSERDA protocol information. Engineering consultants shall include calculations that demonstrate savings and/or demand reduction (kW, kWh, and therms) for NYSERDA potential incentives.

In addition, it is expected that all consultants will comply with this protocol on all projects related to the NYSERDA program.

The specific requirements for each vendor are outlined below.

1) Architect:

The Architect must pursue, in conjunction with NYPH’s Design & Construction and Facilities Operations, all applicable NYSERDA funding opportunities. If funding is pursued, the Architect is responsible for the following:

a. Manage their consultants to ensure the project’s eligibility with current NYSERDA requirements.

b. Ensure all required reports, forms, and applications are completed in accordance to NYSERDA’s current requirements to facilitate these funding needs.

c. Submit all approved energy efficient equipment specifications required by NYSERDA.

d. Ensure all lighting fixtures are on the current qualified product lists that NYSERDA uses to determine eligibility for energy efficiency.

2) Engineers:
NYSERDA requires specific energy savings calculations that are part of NYPH’s commitment to reduce its energy consumption. The intent is to provide information on specific building systems or components that are eligible for NYSERDA incentives. To ensure all eligible NYPH projects comply with the NYSERDA protocol, the Engineer is responsible for the following:

a. Provide the MEP Bases of Design (BOD) Project Description:
   i. Include all existing equipment being removed, replaced or upgraded, which has an energy savings impact.
   ii. Ensure the selection process meets all qualifications set forth in both the NYSERDA incentive program and NYPH’s MEP guidelines. Coordinate with Facilities Engineering, Operations and Design & Construction prior to selection of new equipment.

b. Provide new equipment specifications and/or cut sheets to confirm proposed equipment is meeting NYSERDA efficiency standards.

c. Coordinate field visits with the assigned CM to obtain equipment information.

d. Model all HVAC designs in order to provide energy information for life-cycle cost analysis in accordance to the NYSERDA protocol. The A/E must work together to minimize project costs while maximizing NYSERDA incentives.

e. Calculate the proposed energy savings and/or demand reductions compared to the project’s existing conditions.
   i. Savings should include kW/kWh/therm savings and annual energy cost savings.
   ii. Calculations should be reevaluated as required (i.e. design changes) to provide most up-to-date information.

f. Submit all required documentation for standard and approved equipment (design drawings, specifications, etc.) to the NYSERDA Outreach Coordinator for incentive approval. The Engineer is required to resubmit necessary design documents and project information inclusive of all updates and/or changes.

g. Ensure the project receives final approval for NYSERDA incentives before the CD drawing phase is completed.

3) Construction Manager

NYSERDA requires specific energy savings calculations that are part of NYPH’s commitment to reduce energy consumption. To ensure all eligible NYPH projects comply with the NYSERDA protocol, the CM is responsible for the following:

a. Upon receiving CD documents from the A/E, that NYSERDA incentive opportunities have been vetted.

b. Project submittals shall use approved NYSERDA equipment. This will include coordination with the A/E during the submittal process (i.e. project data) with NYSERDA.
c. Submit the most up-to-date project description, equipment costs, estimated project costs (including materials and labor), energy savings, and associated utility information to the NYSERDA Outreach Coordinator for project submission.

d. Coordinate project schedule and timeline to allow for the NYSERDA technical consultant to perform a pre-inspection before demolition occurs and perform a post-inspection once project is substantially complete.

e. Provide copies of invoices for project purchases, as required, that qualifies for NYSERDA incentives.

4) Project Manager and Consultants:

NYPH requires all PMs/consultants to facilitate the NYSERDA process with Facilities Engineering + Operations Department and ensure compliance of all A/E and CMs involved in the project in order to successfully complete NYSERDA programs. This group is responsible for the following:

a. Communicate on a regular basis with the NYPH’s NYSERDA Programs Coordinator to ensure the process is being followed and project data submissions are up-to-date.

b. Establish a NYSERDA agenda on all project meetings (kick-off meetings, etc.) to achieve the milestones regarding the NYSERDA process.

c. Provide the GMP cost of the MEP work that qualifies for NYSERDA incentives.

5) Process Facilitators:

In order to manage this process, the entire team must coordinate their application process with the NYSERDA Outreach Coordinators. To assist in this process, NYPH has designated a NYSERDA Facilitator to serve as a facilitator and assist with communications between Project team and NYSERDA Outreach Coordinators. Project team shall provide basic project data to the NYPH NYSERDA Facilitator for status tracking through the NYSERDA approval process. The NYSERDA Facilitator will regularly contact the NYSERDA Outreach Coordinators and provide status of the incentive application back to the Project team.

Contact details as follows:

**NYPH’s NYSERDA Facilitator:**
Kathia Benitez, Energy Program Manager
Office: 212.746.0204
E-mail: keb9039@nyp.org

**NYSERDA’s Outreach Coordinator:** Luthin Associates, Inc.
Erin McNally, Project Manager
Office: 732.774.0005
E-mail: emcnally@luthin.com
### NYP - NYSERDA APPLICATION REVIEW FORM

<table>
<thead>
<tr>
<th>Date:</th>
<th>Project Start Date:</th>
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<tr>
<th>Contact:</th>
<th>Project Name:</th>
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<th>Title:</th>
<th>Project Location:</th>
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<tr>
<th>Department:</th>
<th>Project Square Feet:</th>
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<th>Phone:</th>
<th>Project Number:</th>
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<tr>
<th>Email:</th>
<th>Estimate Project Cost:</th>
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<tr>
<th>Project Type:</th>
<th>Feasibility Study</th>
<th>Equipment Replacement</th>
<th>New Construction</th>
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<tr>
<th>Current State of Project Development:</th>
<th>Feasibility/ Design</th>
<th>Schematic</th>
<th>Construction Documents</th>
<th>Other</th>
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If other, please explain:  

Please describe project timeline:  

**Project Narrative/Scope of Work:**

- 
- 

**Will/Does your project incorporate energy efficiency/conservation measures? Please identify.**

**Does the project include or need assistance with energy modeling/energy audit?**

**Have specific project measures, equipment, or scope of work been identified?** (Please include/attach cut sheets)

**If new construction identify construction type: (Choose one)**

- New building or building addition
- Existing building alteration
- Interior construction
- Infrastructure or MEP only (No Architectural)

**If known, state the estimated annual energy (mmbtu/kWh) savings to result from this project:** (Include calculations)

- 
- 

The above information is submitted for the sole purpose of processing a NYSERDA application. This project has been reviewed by the Energy Manager. For assistance contact: Kathia Benitez, Energy Program Manager at 212-746-0204 or via email keb9039@nyp.org.

Name/Signature/Title (By NYP Representative Submitting NYSERDA Application Review Form to Energy Program Manager)

Name/Signature/Title (By Project Manager, Director/Supervisor)

FOR Energy Program Use Only

Date Completed Application Submitted to NYP External Relations for Review and Approval:
PURPOSE OF FORM
Ensure early identification of energy conservation and energy efficiency opportunities within NYP capital projects.
Match project scope with available and applicable NYSERDA grant and rebate opportunities.
Define project timelines to match with NYSERDA requirements and application processing.
Assist Project Managers in coordinating the NYSERDA process with the capital project design and construction process.

GENERAL INFORMATION
NYSERDA - the New York State Energy Research and Development Authority - is a public benefit corporation with the mission to help New York meet its energy goals: reducing energy consumption, promoting the use of renewable energy sources, and protecting the environment. NYSERDA offers cost-sharing, grants and incentive programs for energy audits, feasibility studies, and projects with energy conservation and energy efficiency components. Through the FlexTech Program and its authorized consultants and contractors, NYSERDA can also cost share energy efficiency technical evaluations, process improvement analysis, energy master plans, retrocommissioning, and development of peak-load curtailment plans (PLCPs) of existing facilities, as well as combined heat & power (CHP) feasibility studies for implementation within existing facilities.

NYSERDA LINKS
The following links are NYSERDA Measures Worksheets for use in evaluating incentives applicable to the project.
Worksheets are incentive calculators applicable to new construction, major renovation, replacement or retrofit.
Please submit applicable worksheets with this form.

Existing Facilities Program Lighting Worksheet
Lighting systems - lamps, ballasts, fixtures - and controls.
www.nyserda.ny.gov/efp-lighting

Existing Facilities Program HVAC Worksheet
HVAC systems and controls.
www.nyserda.ny.gov/efp-hvac

Existing Facilities Program Electric Chiller Worksheet
Air-cooled and water-cooled chillers.
www.nyserda.ny.gov/efp-chillers

Existing Facilities Program Motors Worksheet
Totally enclosed fan-cooled (TEFC) and open drip-proof (ODP) high-efficiency electric motors.
www.nyserda.ny.gov/efp-motors

Existing Facilities Program Interval Meter Worksheet
High-accuracy interval meters enabling at least 40KW of demand response.
www.nyserda.ny.gov/efp-interval-meter

Existing Facilities Program Variable Frequency Drive Worksheet
Variable frequency drives (VFD) installed on centrifugal pumps and fans.
www.nyserda.ny.gov/efp-vfd

Existing Facilities Program Commercial Refrigeration Worksheet
High-efficiency commercial refrigerators and freezers; air-cooled or water-cooled ice makers.
http://www.nyserda.ny.gov/EFP_ComCommRefrigeration

Existing Facilities Program Commercial Kitchen and Washers Worksheet
Commercial kitchen equipment - steamers, ovens, griddles, fryers, holding cabinets; commercial washers.
http://www.nyserda.ny.gov/EFP_ComKitchComWash

Existing Facilities Program Natural Gas Efficiency Worksheet
Natural gas-fired high-efficiency furnaces and boilers; water heating and space heating equipment.
Natural gas-fired commercial kitchen equipment - fryers, broilers, ovens, steamers, griddles.
http://www.nyserda.ny.gov/EFP_NaturalGas
Refer to the ASHRAE - Advance Energy Design Guide for Large Healthcare Institutions.

The Advanced Energy Design Guide series provides a sensible approach to easily achieve advanced levels of energy savings without having to resort to detailed calculations or analysis. The four-color Guides offer contractors and designers the tools, including recommendations for practical products and off-the-shelf technology, needed for achieving a 50% energy savings compared to buildings that meet the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004. The energy savings target of 50% is the first step in the process toward achieving a net-zero energy building, which is defined as a building that, on an annual basis, draws from outside resources equal or less energy than it provides using on-site renewable energy sources.

These Guides have been developed through the collaboration of ASHRAE, the American Institute of Architects (AIA), the Illuminating Engineering Society of North America (IES), and the U.S. Green Building Council (USGBC), with support from the Department of Energy (DOE), to help meet all of an owner's energy performance requirements. In an effort to promote building energy efficiency, ASHRAE and its partners have made these Guides available for download (PDF) at no charge.

https://www.ashrae.org/standards-research--technology/advanced-energy-design-guides/50-percent-aedg-free-download
New York Presbyterian Hospital  
Engineering Check List for New Projects in Design

I. ELECTRICAL

1. Identify all power sources within project scope. If panel directories are not available, request house assistance for circuit tracing.

2. Identify all existing panels located outside of electric closets. Determine if panels shall remain or may be removed. Advise the architect immediately if the walls at existing panel locations are marked for demolition.

3. If possible, identify existing vertical risers (such as fire alarm, public address, etc) presently concealed in walls marked for demolition under new scope. Identify relocation of these risers under new scope of work.

4. Compare existing ceiling heights with proposed ceiling heights. Trace all existing work that will become located below new ceiling heights. Mark for relocation in new project scope.

5. Depending on the availability of new infrastructure, include in scope future connection to the infrastructure (where applicable).

6. Depending on the availability of the new infrastructure, include in the budget revisions to the infrastructure to pick up new scope (where applicable).

7. Review project requirements and identify availability of power for new project loads within project scope. Document all power requirements including NYPH supplied equipment. Issue to NYPH for approval.
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<tr>
<td><strong>8.</strong></td>
<td>If deficiencies exist, identify all sources of power outside of the project envelope that can be used to support the project.</td>
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<tr>
<td><strong>9.</strong></td>
<td>Review large equipment access into a project scope. Identify path of travel and all temporary/ or permanent measures necessary for equipment delivery or removal.</td>
</tr>
<tr>
<td><strong>10.</strong></td>
<td>Lighting: See fixture cuts in Appendix for standards. Redocument all fixtures proposed, standard and nonstandard for NYPH's approval.</td>
</tr>
<tr>
<td><strong>11.</strong></td>
<td>Light control: See Specification Section 16410 for standards. Redocument with type of light fixtures for NYPH approval.</td>
</tr>
<tr>
<td><strong>12.</strong></td>
<td>Devices: Use as standard, Hubbell illuminated duplex outlets.</td>
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<tr>
<td><strong>13.</strong></td>
<td>Emergency outlets: See Specification Section 16440 for standards for color identification.</td>
</tr>
<tr>
<td><strong>14.</strong></td>
<td>Plug-in switches to infrastructure busducts, use Siemens-Sentron only.</td>
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<td><strong>15.</strong></td>
<td>Automatic transfer switches with bypass isolation switch, use ASCO only.</td>
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<tr>
<td><strong>16.</strong></td>
<td>Short circuit rating for systems originating from Baker Court services: 65KAIC for 277/ 480v systems, 22kAIC for 120/ 208v systems.</td>
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<tr>
<td><strong>17.</strong></td>
<td>Work in MER areas shall be in rigid conduit.</td>
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<tr>
<td><strong>18.</strong> HVAC/electrical coordination: Electrical engineer shall provide multiple 120v source at electric closet for NYPH telecom and security requirements. HVAC shall specify 120/24v control transformer to feed multiple 24v VAV boxes. 24v wiring by HVAC (or BMS) contractor.</td>
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<tr>
<td><strong>19.</strong> Architect to furnish/ coordinate locations and elevations of electrical outlets switches, devices, etc.</td>
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<tr>
<td><strong>20.</strong> For larger projects acquire services of contractor (additional scope) to verify/ trace the existing circuits within the project scope. For smaller projects request same from NYPH Engineering Staff. Document areas of impact due to shut downs.</td>
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<tr>
<td><strong>21.</strong> If required provide power for telecom equipment <em>(minimum two quad outlets)</em>, security systems (MSI) <em>(minimum two quad outlets)</em> and provide stub-up’s for card readers <em>(coordinate with Security Dept.)</em></td>
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<td><strong>22.</strong> Coordinate locations of exit signs with architect, provide in corridors at all changes in direction. If in doubt, indicate additional signs.</td>
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<tr>
<td><strong>23.</strong> Review any new type of lighting design concept with OFO, lighting consultant and manufacturer i.e.; fiber optics, also provide 20% for attic stock of specialty bulbs</td>
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<tr>
<td><strong>24.</strong> Confirm all locations of switches, fire alarm devices, speakers etc. with architect and coordinate with furniture layouts, signage and interior elevations.</td>
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New York Presbyterian Hospital
Engineering Check List for New Projects in Design

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<th></th>
<th>Engineer</th>
<th>NYPH</th>
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<tbody>
<tr>
<td>25.</td>
<td>Confirm all plumbing and HVAC electrical loads are adequately sized and are shown on drawings, i.e., pumps, heat tracing etc.</td>
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<tr>
<td>27.</td>
<td>Confirm the emergency power system is energized to insure emergency power is available for the required equipment/devices.</td>
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II. HVAC

<table>
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<tr>
<th></th>
<th>Engineer</th>
<th>NYPH</th>
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<tbody>
<tr>
<td>1.</td>
<td>Request owner to provide adequate access openings in the ceiling and walls to determine existing conditions.</td>
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<tr>
<td>2.</td>
<td>Schedule time to survey the area. Prepare drawings for use in demo or design. All existing piping and ductwork to remain should be noted on drawings and incorporated in the project’s scope of work. Remove all abandoned or unused piping from ceilings, walls, etc. Update drawings as required after demolition phase.</td>
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<tr>
<td>3.</td>
<td>Prepare report for existing piping and ductwork that needs to be replaced. Indicate impacts to adjacent areas and discuss with NYPH Engineering staff.</td>
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<tr>
<td>4.</td>
<td>Alert owner of any work impacting critical areas during the design phase.</td>
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<tr>
<td>5.</td>
<td>Tie-ins to all existing services (CHW, air, control air, etc) shall be coordinated with NYPH at the design phase.</td>
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New York Presbyterian Hospital
Engineering Design Standards

Appendix

February 1, 2000
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<tr>
<td>6.</td>
<td>Access of equipment, equipment travel (routing) should be reviewed and coordinated with NYPH.</td>
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<tr>
<td>7.</td>
<td>Establish design requirements by meeting with users and NYPH Staff. Include all relevant DDC system requirements. Document all design requirements and issue for NYPH approval.</td>
</tr>
<tr>
<td>8.</td>
<td>Prepare pre-schematic design to develop project budgets.</td>
</tr>
<tr>
<td>9.</td>
<td>Acquire ventilation test report from certified balancing contractor during the design phase to verify actual air quantities and pressures in existing systems. Review results with NYPH, OFO and project manager.</td>
</tr>
<tr>
<td>10.</td>
<td>No Trane equipment will be used.</td>
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<tr>
<td>11.</td>
<td>Only ABB drives will be used.</td>
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<tr>
<td>12.</td>
<td>All controls shall be connected to DDC system unless approved by NYPH engineering staff. All smoke dampers shall be pneumatic type. Document all system features including alarms for NYPH approval.</td>
</tr>
<tr>
<td>13.</td>
<td>All air-conditioning units shall have 40–45% efficiency prefilters.</td>
</tr>
<tr>
<td>14.</td>
<td>Cooling coils shall have a maximum of 11 (eleven) fins per inch.</td>
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New York Presbyterian Hospital  
Engineering Check List for New Projects in Design

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<tr>
<th>No</th>
<th>Requirement</th>
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<tr>
<td>16</td>
<td>No air cooled DX type air-conditioning equipment shall be used. If local package units for supplementary air-conditioning are required, they shall be glycol cooled type.</td>
</tr>
<tr>
<td>17</td>
<td>Multiple belts shall be provided on all fan drives.</td>
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<tr>
<td>18</td>
<td>Indicate on drawings location of equipment housekeeping pads.</td>
</tr>
<tr>
<td>19</td>
<td>Indicate equipment dimensions on both A&amp;E drawings. Equipment should fit within the confines of MER and provide adequate clearances for servicing. Inform architect and NYPH of any anticipated problems.</td>
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<tr>
<td>20</td>
<td>Make design team aware of all locations requiring access panels, especially access to fire dampers, controls, etc.</td>
</tr>
<tr>
<td>21</td>
<td>As-built drawings and O&amp;M manuals shall be furnished to OFO for all projects.</td>
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III. PLUMBING

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<tr>
<th>No</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>1</td>
<td>Confirm locations of existing stacks (W,V, AW, HW, CW), risers (G) and leaders (SW).</td>
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<tr>
<td>2</td>
<td>Confirm locations of existing medical gas risers (V,A, O₂) and valve boxes, main shut-off valves and alarm panels.</td>
</tr>
<tr>
<td></td>
<td>New York Presbyterian Hospital Engineering Check List for New Projects in Design</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3</td>
<td>Schedule survey to confirm all existing and/or abandoned piping in ceilings and note on construction drawings to be removed or remain if active. Schedule follow-up survey after demolition and update drawings as required.</td>
</tr>
<tr>
<td>4</td>
<td>Discuss/confirm project scope and all connections to existing stacks and risers with NYPH engineering staff.</td>
</tr>
<tr>
<td>5</td>
<td>Confirm that all removed piping from project scope does not supply fixtures in an adjacent area or floor below or above.</td>
</tr>
<tr>
<td>6</td>
<td>Verify that existing piping within project scope does not impact any critical areas i.e. OR’s, procedure rooms etc. if so discuss with engineering staff during design phase.</td>
</tr>
<tr>
<td>7</td>
<td>Verify conditions of existing piping noted to remain and if deteriorated, review with engineering staff to replace same during new project construction.</td>
</tr>
<tr>
<td>8</td>
<td>Coordinate existing piping to remain (locations and elevations) with new work of other trades (HVAC, Electrical, FP).</td>
</tr>
<tr>
<td>9</td>
<td>Confirm water pressure is adequate to operate all fixtures/equipment specified.</td>
</tr>
<tr>
<td>10</td>
<td>Verify path for equipment to travel through hospital to project site and confirm openings are adequate size along path.</td>
</tr>
<tr>
<td>11</td>
<td>Review list of manufacturers for all plumbing products with engineering staff prior to writing specifications.</td>
</tr>
</tbody>
</table>

New York Presbyterian Hospital Engineering Design Standards

Appendix
February 1, 2000

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New York Presbyterian Hospital
Engineering Check List for New Projects in Design

12. Connect new H&CW supplies to new infrastructure risers, (two locations per wing except for FW, each with valved capped connections) (where applicable).

13. Provide electric heat maintenance strips (HWAT) on all hot water piping to fixtures which are supplied from new infrastructure risers (where applicable).

14. Provide shut-off valves on all branches to fixtures.

15. All equipment to be duplex (provide standby).

16. Confirm all required pipe insulation is clearly specified especially on piping requiring freeze protection.

17. Contractor to indicate on shop drawings all equipment dimensions including concrete pads and coordinate with other equipment in MER to assure proper isle space and accessibility.

18. As-built drawings and O&M manuals shall be furnished to OFO on all projects.

IV. FIRE PROTECTION

1. Verify if existing area is sprinklered and extent of piping system. Type of existing sprinklers.

2. Identify existing water supply source, location, size, PRV type and size, pressure gauge reading before and after PRV. Control valve number and sprinkler zone if noted.

---

New York Presbyterian Hospital
Engineering Design Standards

Appendix
February 1, 2000

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<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>3.</td>
<td>Identify existing fire alarm zones. Review and coordinate impacts to existing zones with NYPH Fire Safety Director.</td>
</tr>
<tr>
<td>4.</td>
<td>Locate existing smoke doors in corridor. Review any revisions to locations with NYPH Fire Safety Director.</td>
</tr>
<tr>
<td>5.</td>
<td>Locate existing fire hose stations and fire extinguishers within area of work, supply piping and source.</td>
</tr>
<tr>
<td>6.</td>
<td>Note existing ceiling heights, existing piping elevations and condition of piping.</td>
</tr>
<tr>
<td>7.</td>
<td>Locate existing drain and test connection, drain riser.</td>
</tr>
<tr>
<td>8.</td>
<td>Coordinate boundary of sprinkler zones with fire alarm zones with NYPH Fire Safety Director.</td>
</tr>
<tr>
<td>9.</td>
<td>Review travel distance to existing fire hose stations to remain, to be relocated. Add auxiliary hose station if required. Coordinate location with architect.</td>
</tr>
<tr>
<td>10.</td>
<td>Review location of existing portable fire extinguisher cabinets to remain, to be relocated or to be added if required. Confirm type and size at each location. Confirm if multiple units are required and must be housed in larger cabinets.</td>
</tr>
<tr>
<td>11.</td>
<td>Review location of existing/ new FCA, drain and test connection with architect and NYPH, OFO.</td>
</tr>
<tr>
<td>12.</td>
<td>Coordinate location of existing/ new tramper and water flow alarm switches with Fire Alarm.</td>
</tr>
</tbody>
</table>
New York Presbyterian Hospital  
Engineering Check List for New Projects in Design

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>Replace existing combination control/PRV with new control valve and tamper switch and new PRV “CLA-VAL” type only. Replace existing water flow switch.</td>
</tr>
<tr>
<td>14.</td>
<td>Review reflected ceiling plan, ceiling elevation, section, lights, diffusers, speakers, exit signs, ceiling mounted equipment, curtain tracks, equipment tracks or supports, light tracks.</td>
</tr>
<tr>
<td>15.</td>
<td>Verify height of shelving, cabinets and storage racks. Coordinate location of sprinkler head in closets with architect to clear shelves.</td>
</tr>
</tbody>
</table>

V. FIRE ALARM

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NYPH OFD Coordination (Prior to design), with NYPH Facilities (Health &amp; Safety, Security, Electrical and HVAC) regarding all projects.</td>
</tr>
<tr>
<td>2.</td>
<td>Submit ALL Projects to the NYPH Fire Alarm Subcommittee (or NYPH’s Designated Fire Alarm Consultant) for coordination and approval.</td>
</tr>
<tr>
<td>3.</td>
<td>Identify ALL Fire Alarm Zones/Systems affected by the Project.</td>
</tr>
<tr>
<td>4.</td>
<td>Confirm the locations of all existing Fire Alarm Devices, Smoke Detectors, Duct Detectors, Audible Devices, Visual Devices and all signaling and addressable risers.</td>
</tr>
</tbody>
</table>
New York Presbyterian Hospital  
Engineering Check List for New Projects in Design

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Existing Code deficient items, existing electrical defects and/or Violations located within or adjacent to the Project envelope must be identified and corrected within the Project. For adjacent areas, discuss scope with OFD, could be add alternate to project.</td>
</tr>
<tr>
<td>6.</td>
<td>Coordinate with MEP Engineer the locations of all equipment required to be monitored and/or controlled by the Fire Alarm System (IE: Waterflow, Tamper, Sub-Systems, Security Devices, Door Holders, Etc.).</td>
</tr>
<tr>
<td>7.</td>
<td>Coordinate with MEP Engineer the locations of emergency power sources available for the Fire Alarm System or Strobe Panel.</td>
</tr>
<tr>
<td>8.</td>
<td>Coordinate with MEP Engineer the locations of all equipment required to be monitored and/or controlled by the fire alarm system (i.e., waterflow, tamper, sub-systems, security devices, door holders, etc.).</td>
</tr>
<tr>
<td>10.</td>
<td>Ensure that ALL applicable Codes are addressed and incorporated (NYCBC, NYCEC, NYCFC, ADA, NFPA).</td>
</tr>
<tr>
<td>11.</td>
<td>File Contract Documents with the New York City Building Department and Fire Department via NYPH approved Expediting Service.</td>
</tr>
<tr>
<td>12.</td>
<td>Pre-Test ALL Fire Alarm System components prior to the Fire Department acceptance test, in accordance with Fire Department Regulations.</td>
</tr>
<tr>
<td>13.</td>
<td>Submit ALL Fire Department Approvals, Defects or Violations to NYPH Health and Safety.</td>
</tr>
</tbody>
</table>
New York Presbyterian Hospital
Engineering Check List for New Projects in Design

| 14. | Submit AutoCAD architectural files to NYPH Health & Safety for update of the existing Fire Alarm System Graphic Annunciation Maps. | ENGINEER | NYPH |

VI. GENERAL

| 1. | No project shall be turned over until MEP punchlist have been signed off by all parties including OFO. | | |

New York Presbyterian Hospital
Engineering Design Standards

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Appendix
February 1, 2000
CAPITAL ASSET PLANNING & DEVELOPMENT

CAD Standards

Facility and Construction Documentation
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2. CAD DRAWING PRODUCTION

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  Electronic File Format
  Scale, Units and Tolerances
  Fonts and Text Styles
  Block
  Title Block
  Use Disclaimer
  Policy on Model Space and Paper Space
  Policy on External Reference Files

• LAYERING
  Standard Layer List
  Name Formatting
  General Rules about Uses
  Attributes (Colors, Pens, Linetypes)

• FILE NAME CONVENTIONS
  Building and Floor Identification Codes
  Discipline Identification Codes
  Drawing Type Codes
  Drawing Numbers

• POLICY on CAD FILE TRANSLATION
  Full AutoCAD Compliance
  Translation Testing Recommended
INTRODUCTION

Capital Asset Planning and Development has revised this document for production starting 2009. It represents the second major revision of New York Presbyterian Hospital’s CAD standards. Prior versions were published in 1999. The revisions in this edition focus on obtaining AutoCAD design drawings, project record set drawings & as-built drawings within the disciplines of (Architectural, Structural, Mechanical, Electrical, Plumbing and Fire Life Safety) prior to capital project closeout, a use disclaimer, a new layout standard, and electronic file qualities. The purpose of this document is to serve as a tight specification for producing and delivering CAD drawings for facility documentation projects and construction projects. The guidelines are intended to ensure the successful use and control of CAD systems and data throughout NYPH.

Before a capital project can be closed out and final payment from New York Presbyterian Hospital rendered, all specified materials must be submitted to the appropriate NYPH project manager or representative in accordance with production standards and special instructions described throughout this document. See also the publication Capital Projects Closeout Requirements for the list of closeout requirements.

A signed copy of the Electronic File Quality Assurance Checklist found in section one of this document must also be submitted with CAD drawings and scans being delivered during the closeout phase of CAPS projects. When an Electronic Quality Assurance Checklist has been signed and submitted, the vendor (architect, engineer, contractor, etc.) is assuring that all materials adhere to the standards and guidelines set forth in this document.

The layering standard outlined herein is a slightly modified version of the 1997 American Institute of Architects CAD Layer Guidelines. However, please note that NYPH follows its own guidelines for naming and organizing CAD files, instead of following the 1997 AIA recommendations in these areas.

Please direct any questions or comments about this document to the address below.

New York Presbyterian Hospital/Weill Cornell University
Facilities Development Office
523 East 70th Street
Annex Bldg .Floor 10
New York, NY 10021.
tel: 212-746-7825
e-mail: ann9025@nyp.org
SECTION 1.0.0 – CAD QUALITY ASSURANCE CHECKLIST

CAD drawings delivered upon closeout of a CAPS project must be accompanied by submission of the following checklist. When a checklist has been signed and submitted, the vendor (architect, engineer, contractor, etc.) is assuring that all materials adhere to the standards and guidelines set forth in this document.

FILE FORMAT AND SETUP
- Electronic File Format
- Scale, Units, & Tolerances
- Fonts and Text Styles
- Blocks
- Title Blocks
- Policy on Model Space and Paper Space
- Policy on External Reference Files (XREFs)

LAYERING
- Standard Layer List
- Layer Name Formatting
- General Rules about Naming and Uses
- Layer Attributes (Colors, Pens, Linetypes)

CAD & TIFF FILE NAME CONVENTIONS
- Building and Floor Identification Codes
- Discipline Identification Codes
- Drawing Type Codes
- Drawing Numbers

POLICY ON CAD FILE TRANSLATION
- Full AutoCAD Compliance
- Translation Testing Procedures (if applicable)

POLICY ON TIFF FILE TRANSLATION
- Scan at 600 dpi
- Files must be uncompressed

Signature of Accountable Vendor Representative____________________________________
Phone Number _________________________________________________________________
Date _________________________________________________________________________
SECTION 2.0.0 – CAD DRAWING PRODUCTION

FILE FORMAT and SETUP

Electronic File Format

Facility documentation drawings and construction project drawings must be submitted to NYPH in full compliance with AutoCAD 2004 software (file extension = .DWG). Throughout this document, the use of the name AutoCAD always implies “AutoCAD 2004” unless otherwise noted.

Scale and Units

All CAD drawing models should be drafted at full scale in architectural units, such that one drawing unit equals one inch.

Tolerances

For Facility Documentation Drawings

Typically it is required that exterior building dimensions recorded within CAD drawings must reconcile to within 1 inch of actual building dimensions as measured in the field, and interior building dimensions must reconcile to within 1/2 inch of actual field dimensions. However, individual project specifications may vary. Please confirm dimension error tolerances for each project with your NYPH client representative.

For Construction Drawings

Tolerances for construction drawings are implicit within professional service contracts.

Fonts & Text Styles

For Facility Documentation Projects

Only font Arial True Type is approved for use, unless otherwise agreed by the requesting NYPH client representative. Any text style using this font would be allowed.

Dimensions, labels and notes, when requested as part of the project, should not appear larger than 1/4” or smaller than 1/8” height on printed drawings, and drawing titles should not appear larger than 1/2” height on printed drawings.

For Construction Projects

Text styles and fonts may vary, but the use of font Arial True Type for most applications is desirable. Special fonts which are not packaged with AutoCAD are not allowed. Dimensions, labels and notes, should not less than 1/8” height on printed drawings.

Blocks

NYPH is currently not imposing the use of any particular block definitions or block libraries. However, NYPH requires that the following general rules be employed when handling block entities:

1. All entities within a block must be created on layer 0.
2. Drawing entities translated into AutoCAD blocks from non-AutoCAD systems must revert to layer 0 when exploded within AutoCAD.
3. File translation from non-AutoCAD systems which result in wall blocks within AutoCAD are unacceptable.
Title blocks

Each CAD file submitted to NYPH should have only one title block. If using paper space, the title block should be placed with its lower left hand corner point inserted at a coordinate location of (0,0,0). Depending on the purpose of the drawing, facility documentation or construction, the drawing’s title block should contain certain essential information that NYPH needs to store and retrieve each drawing in its library.

Title Blocks for Facility Documentation Drawings
Each NYPH department may have its own title block that it would like to see matched with drawings of facilities that it owns. Specifications for these title blocks will vary. See your NYPH client for exact title block specifications. A generic New York Presbyterian Hospital title block template is available for use if there is no other available.

Title Blocks for Construction Drawings
Consulting architects and engineers must use the New York Presbyterian Hospital title block template or a modified version provided by your NYPH client.

List of Faculties/Departments with available title blocks:
- New York Presbyterian Hospital - generic title block
- Capital Asset Planning and Development Group

At minimum, these title blocks should contain all of the information listed below.

Project Information:
- Firm Name - representing the drawing author
- Project Name - as specified by NYPH
- Building Code - as specified by NYPH
- Building Name - specify only if the project name does not include this information already, and the project is building specific
- Project Number - assigned by the Vendor

Drawing Information:
- Drawing Title - indicating the drawing content, e.g. floor plan, section, detail, etc.
- Drawing Number
- Date of Drawing - original drawing date including significant revision dates
- Drawing Scale - representing the intended plot scale of the drawing with title block
- North Arrow

Policy on Model Space and Paper Space

NYPH requires that each CAD file submitted as a project deliverable contains only one drawing model with one title block, using either of the following setup methods. Note that some NYPH faculties or departments that contract with Preferred CAD Vendors to provide facility documentation drawings may express a preference for one method to be used instead of another. In this case, please see your NYPH client representative for specific preferences.

Method #1 -- Model Space Only. Both the drawing model and the drawing’s title block are contained in the same model space environment within a single CAD file. The paper space environment is not used.

Method #2 -- Model Space and Paper Space Combined. Each CAD file is set up to contain only one title block in paper space which references the building model contained in model space.
Use Disclaimer

All construction documents must include the following disclaimer (already placed on the NYPH border template): “Warning: This document may contain sensitive security information and therefore must be treated as a confidential document. The information contained in this document must be maintained in a confidential manner to prevent compromising homeland security as provided in Section 214 of the Homeland Security Act of 2002. No part of this document shall be reproduced, released or distributed without the express written permission of New York Presbyterian Hospital. Unauthorized reproduction, release or distribution may result in civil penalty or other action by New York Presbyterian Hospital."

Policy on External Reference Files (XREFs)

Revision 1.1
The following revision supersedes previous CAD drawing deliverables
NYPH will accept submitted drawing packages created using AutoCAD E-Transmit function. NYPH accepts AutoCAD drawing files saved in version 2007. AutoCAD file version is to be previously specified if vendor cannot save to version 2007.

NYPH will not accept the submission of any CAD drawing deliverable which contains references to external source drawing files. All externally referenced data sources that were used during the CAD drawing production phase should be inserted and retained as a block within a single drawing file, including the title block, upon project completion and prior to drawing delivery to NYPH. The resulting self contained drawing file is an acceptable deliverable to NYPH.
LAYERING

NYPH has adopted most of the layer name and use rules recommended by the *CAD Layer Guidelines* published in 1997 by the American Institute of Architects (AIA). AIA recommendations which have been adopted by NYPH are included in this section. Where noted, NYPH has supplemented the AIA guidelines with its own rules and standards, as necessary.

**Standard Layer Listing**

This section contains a partial list of AIA recommended layers to be used when producing facility documentation drawings and construction drawings for New York Presbyterian Hospital, along with special layers identified for institutional space management purposes.

Core layers identified below by a diamond symbol (♦) are to be used by Preferred CAD Vendors producing facility documentation drawings. Depending on the requesting NYPH faculty or department, the core layer list and attributes of core layers may vary somewhat from project to project. In this case, see your NYPH client representative for preferences. Core layers should also be used as the basis for construction drawings, supplemented as necessary by other layers in the standard listing.

If necessary for construction drafting purposes, please refer to the *Master Layer List* in the 1997 AIA *CAD Layer Guideline*, pages 16-23, for additional layer names. If the *Master Layer List* is not sufficient, new layer names may be added using the formatting rules described in the next section entitled *Layer Name Formatting*, and as defined by the 1997 AIA *CAD Layer Guidelines*, pages 13-15.

<table>
<thead>
<tr>
<th>CORE</th>
<th>Name</th>
<th>Description</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦</td>
<td>Architectural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-ANNO-DIMS</td>
<td>Annotations, Dimensions</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-KEYN</td>
<td>Annotations, Keynotes</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-LEGN</td>
<td>Annotations, Legends, Symbol keys</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-NOTE</td>
<td>Annotations, Notes</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-NPLT</td>
<td>Annotations, Non-plotting graphic information</td>
<td>9-lt gray</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-PATT-CNST</td>
<td>Annotations, Texture or hatch patterns, Under construction</td>
<td>30</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-PATT-RMDL</td>
<td>Annotations, Texture or hatch patterns, To be remodeled</td>
<td>140</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-REDL</td>
<td>Annotations, Redlines</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-REVC</td>
<td>Annotations, Revision clouds</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-SYMB</td>
<td>Annotations, Symbols</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-TEXT</td>
<td>Annotations, Text</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>A-ANNO-TTTLB</td>
<td>Annotations, Border and title block</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>A-CLNG</td>
<td>Ceilings</td>
<td>8-dk gray</td>
<td>continuous</td>
</tr>
<tr>
<td>A-CLNG-GRID</td>
<td>Ceilings, Grid lines</td>
<td>8-dk gray</td>
<td>continuous</td>
</tr>
<tr>
<td>A-CLNG-PATT</td>
<td>Ceilings, Texture or hatch patterns</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>A-CLNG-SUSP</td>
<td>Ceilings, Suspended elements</td>
<td>9-lt gray</td>
<td>continuous</td>
</tr>
<tr>
<td>♦</td>
<td>A-COLS</td>
<td>Columns</td>
<td>6-magenta</td>
</tr>
<tr>
<td>♦</td>
<td>A-COLS-GRID</td>
<td>Columns, Grid lines</td>
<td>6-magenta</td>
</tr>
<tr>
<td>♦</td>
<td>A-DOOR</td>
<td>Doors</td>
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<td>♦</td>
<td>A-DOOR-IDEN</td>
<td>Doors, Identification Tags</td>
<td>4-cyan</td>
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<td>♦</td>
<td>A-DOOR-NOTE</td>
<td>Doors, Notes</td>
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</tr>
<tr>
<td>♦</td>
<td>A-EQPM</td>
<td>Equipment</td>
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<td>A-EQPM-ABOV</td>
<td>Equipment, Elements above</td>
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<td>continuous</td>
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<tr>
<td>A-EQPM-CLNG</td>
<td>Equipment, Ceiling</td>
<td>91</td>
<td>continuous</td>
</tr>
<tr>
<td>A-EQPM-FIXD</td>
<td>Equipment, Fixed equipment</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>A-EQPM-IDEN</td>
<td>Equipment, Identification Tags</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Color</td>
<td>Type</td>
</tr>
<tr>
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<td>------------------------------------------------------------------------------</td>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>A-EQPM-MOVE</td>
<td>Equipment, Moveable equipment</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FIXT</td>
<td>Plumbing fixture</td>
<td>3-green</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-BLOW</td>
<td>Floor, Elements Below</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-CASE</td>
<td>Floor, Casework</td>
<td>31</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-EQPM</td>
<td>Floor, Equipment</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-EQPM-IDEN</td>
<td>Floor, Equipment, Identification Tags</td>
<td>8-dk gray</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-EVTR</td>
<td>Floor, Elevator cars and equipment</td>
<td>3-green</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-HRAL</td>
<td>Floor, Handrails, guard rails</td>
<td>3-green</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-IDEN</td>
<td>Floor, Identification Tags</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-LEVL</td>
<td>Floor, Level changes, ramps, pits, depressions</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-LEVL-NOTE</td>
<td>Floor, Level changes, ramps, pits, depressions, Notes</td>
<td>1-red</td>
<td>continuous</td>
</tr>
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<td>A-FLOR-MILL</td>
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<td>6-magenta</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-MILL-PATT</td>
<td>Floor, Millwork (field-built cabs/counters) Hatch patterns</td>
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<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-NOTE</td>
<td>Floor, Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-OPEN</td>
<td>Floor, Openings</td>
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<td>continuous</td>
</tr>
<tr>
<td>A-FLOR-PATT</td>
<td>Floor, Texture or hatch patterns</td>
<td>7-white</td>
<td>continuous</td>
</tr>
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## Fire Protection

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**Interior**

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**Landscaping**

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**Mechanical**

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<td>--------------------------------------------------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>M-HVAC-SUPP-DUCT</td>
<td>HVAC, Supply Ducting</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-LGAS-EQPM</td>
<td>Lab Gas, Equipment</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-LGAS-NOTE</td>
<td>Lab Gas, Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>M-LGAS-PIPE</td>
<td>Lab Gas, Piping</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-MDGS-EQPM</td>
<td>Medical Gas, Equipment</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-MDGS-NOTE</td>
<td>Medical Gas, Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>M-MDGS-PIPE</td>
<td>Medical Gas, Piping</td>
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<td>continuous</td>
</tr>
<tr>
<td>M-MKUP-DUCT</td>
<td>Make Up Air, Ductwork</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-MKUP-EQPM</td>
<td>Make Up Air, Equipment</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-MKUP-NOTE</td>
<td>Make Up Air, Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>M-NGAS-EQPM</td>
<td>Natural gas, Equipment</td>
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<td>continuous</td>
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<tr>
<td>M-NGAS-NOTE</td>
<td>Natural gas, Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>M-SPCL</td>
<td>Special systems</td>
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<td>continuous</td>
</tr>
<tr>
<td>M-SPCL-EQPM</td>
<td>Special Equipment</td>
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<td>continuous</td>
</tr>
<tr>
<td>M-SPCL-PIPE</td>
<td>Special Piping</td>
<td></td>
<td>continuous</td>
</tr>
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<td>M-STEM</td>
<td>Steam systems</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-STEM-CONP</td>
<td>Steam, Condensate piping</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-STEM-CONP-NOTE</td>
<td>Steam, Condensate piping General text &amp; notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>M-STEM-EQPM</td>
<td>Steam, Equipment</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-STEM-HPIP</td>
<td>Steam, High pressure/hot water piping</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-STEM-LPIP</td>
<td>Steam, Low pressure piping</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-STEM-LPIP-RETN</td>
<td>Steam, Low pressure piping Return</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>M-STEM-LPIP-SUPP</td>
<td>Steam, Low pressure piping Supply</td>
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<td>continuous</td>
</tr>
<tr>
<td>M-STEM-MPIP</td>
<td>Steam, Medium pressure piping</td>
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<td>continuous</td>
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<tr>
<td>M-STEM-NOTE</td>
<td>Steam, Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
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<td>P-ANNO-TEXT</td>
<td>General Text</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-ANNO-SYM</td>
<td>Symbols</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-ANNO-LEGN</td>
<td>Legends and schedules</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-ANNO-TTLB</td>
<td>Border and Title Block</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-ANNO-NOTE</td>
<td>Job Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>P-ACID</td>
<td>Acid, alkaline, oil waste systems</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-ACID-PIPE</td>
<td>Acid, alkaline, oil waste piping</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-DOMW</td>
<td>Domestic hot and cold water systems</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-DOMW-CPIP</td>
<td>Domestic Water, Cold water piping</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-DOMW-EQPM</td>
<td>Domestic Water, Equipment</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-DOMW-HPIP</td>
<td>Domestic Water, High pressure/hot water piping</td>
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<td>P-DOMW-NOTE</td>
<td>Domestic Water, Notes</td>
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<td>continuous</td>
</tr>
<tr>
<td>P-DOMW-RPIP</td>
<td>Domestic Water, Return water piping</td>
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<td>continuous</td>
</tr>
<tr>
<td>P-DOMW-RISR</td>
<td>Domestic hot and cold water risers</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-EQM</td>
<td>Miscellaneous equipment</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-FIXT</td>
<td>Fixtures, toilets, sinks</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-SANR</td>
<td>Sanitary drainage</td>
<td></td>
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</tr>
<tr>
<td>P-SANR-EQPM</td>
<td>Sanitary, Equipment</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>P-SANR-NOTE</td>
<td>Sanitary, Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>P-SANR-FIXT</td>
<td>Sanitary, Plumbing fixtures</td>
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<tr>
<td>P-SANR-FLDR</td>
<td>Sanitary, Floor drains</td>
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<tr>
<td>P-SANR-PIPE</td>
<td>Sanitary piping</td>
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<td>continuous</td>
</tr>
<tr>
<td>P-SANR-RISR</td>
<td>Sanitary risers</td>
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<td>continuous</td>
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### Structural

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Color</th>
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</thead>
<tbody>
<tr>
<td>S-ANNO-TEXT</td>
<td>General Text</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>S-ANNO-SYM</td>
<td>Symbols</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>S-ANNO-LEGN</td>
<td>Legends and schedules</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>S-ANNO-DIMS</td>
<td>Dimensions</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>S-ANNO-TTLB</td>
<td>Border and Title</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>S-ANNO-NOTE</td>
<td>Job Notes</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>S-BEAM</td>
<td>Beams</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>S-COLS</td>
<td>Columns</td>
<td>6-magenta</td>
<td>Center</td>
</tr>
<tr>
<td>S-COLS-GRID</td>
<td>Column grid</td>
<td>6-magenta</td>
<td>continuous</td>
</tr>
<tr>
<td>S-FNDN</td>
<td>Foundation</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>S-FNDN-PILE</td>
<td>Piles, drilled piers</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>S-FNDN-RBAR</td>
<td>Foundation reinforcing</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>S-GRID-DIMS</td>
<td>Column grid dimensions</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>S-GRID-EXTR</td>
<td>Column grid outside building</td>
<td></td>
<td>continuous</td>
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<tr>
<td>S-GRID-IDEN</td>
<td>Column grid tags</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>S-GRID-INTR</td>
<td>Column grid inside building</td>
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<td>continuous</td>
</tr>
<tr>
<td>S-WALL</td>
<td>Structural bearing or shear walls</td>
<td></td>
<td>continuous</td>
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</tbody>
</table>

### Telecomm

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Color</th>
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</thead>
<tbody>
<tr>
<td>T-ANNO-TEXT</td>
<td>General Text</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>T-ANNO-SYM</td>
<td>Symbols</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>T-ANNO-LEGN</td>
<td>Legends and schedules</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>T-ANNO-TTLB</td>
<td>Border and Title Block</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>T-ANNO-NOTE</td>
<td>Job Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>T-CABL</td>
<td>Cable plan</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>T-DIAG</td>
<td>Diagram</td>
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<td>continuous</td>
</tr>
<tr>
<td>T-EQPM</td>
<td>Equipment plan</td>
<td></td>
<td>continuous</td>
</tr>
<tr>
<td>T-JACK</td>
<td>Data/telephone jacks</td>
<td></td>
<td>continuous</td>
</tr>
</tbody>
</table>

### NYPH Use

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Color</th>
<th>Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-ANNO-NOTE</td>
<td>Annotations, Notes</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-TEXT</td>
<td>Annotations, Text</td>
<td>253</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-REDL</td>
<td>Redlines</td>
<td>1-red</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-SYM</td>
<td>Symbols</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-LEGN</td>
<td>Legends and schedules</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-DIMS</td>
<td>Dimensions</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-TTLB</td>
<td>Annotations, Border and title block</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-NOTE</td>
<td>Job Notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-NPLT</td>
<td>Construction lines, non-plotting information, viewports</td>
<td>7-white</td>
<td>continuous</td>
</tr>
<tr>
<td>U-ANNO-KEYN</td>
<td>Key notes</td>
<td>4-cyan</td>
<td>continuous</td>
</tr>
<tr>
<td>U-CORN-NICN</td>
<td>Cornell University, Not in contract</td>
<td>253</td>
<td>continuous</td>
</tr>
<tr>
<td>U-PROJ-AREA-DEPT</td>
<td>Project specific, Area designation Hospital Dept</td>
<td>2-yellow</td>
<td>continuous</td>
</tr>
<tr>
<td>U-SPAC-AREA</td>
<td>Space, Area designation</td>
<td>3-green</td>
<td>continuous</td>
</tr>
<tr>
<td>U-SPAC-AREA-RENT</td>
<td>Space, Area designation, Rentable area</td>
<td>1-red</td>
<td>continuous</td>
</tr>
</tbody>
</table>
Layer Name Formatting

As recommended by the 1997 AIA CAD Layer Guidelines, layer names may be as short as six characters (discipline code + major group) or as long as sixteen characters (discipline code + major group + minor group + status). Here are the four examples of acceptable formula variations, with explanations of formula variables found below:

# 1 A-WALL = discipline code + major group
# 2 A-WALL-FULL = discipline code + major group + minor group
# 3 A-WALL-DEMO = discipline code + major group + status code
# 4 A-WALL-FULL-DEMO = discipline code + major group + minor group + status

**Discipline Code:**
The discipline code is a two-character field with the second character either a hyphen or a user-defined modifier. The predefined discipline codes are the same for both layer names and file names. For a complete list of discipline codes, see Naming Construction Drawings under File Name Conventions.

**Major Group:**
The major group designation is a four-character field that identifies the building system, such as doors, walls, windows, etc. Although most major groups are logically associated with specific discipline codes, it is possible to combine major group codes with any of the discipline codes. For example, AWALL or I-WALL.

**Minor Group:**
This is an optional, four-character field for further differentiation of major groups. For example, partial height walls (A-WALL-PART) might be differentiated from full height walls (A-WALL-FULL). The following common modifiers defined by the AIA can also be used in the minor group field:

IDEN identification tags example: A-DOOR-IDEN
PATT cross hatching, poche example: A-WALL-PATT

If necessary, the minor group field may also be defined by the user, allowing additional layers to be added to accommodate special project requirements. However, this should only be done after checking the Master Layer List in the 1997 AIA CAD Layer Guidelines to see if any of the predefined layer names in that list would meet the special project requirements.
Status Field:
The status field is an optional four-character designator that differentiates new construction from
remodeling and existing to remain. It is only needed when phases of work must be differentiated, and can
be used in place of or in addition to a minor group designation, such as A-WALL-NEWW or AWALL-
FULL-NEWW. In either case, the status field is always the last four-characters of the layer name. Defined
values for this field as defined by the AIA are as follows:

NEWW new work
EXST existing to remain
DEMO existing to demolish
FUTR future work
TEMP temporary work
MOVE items to be moved
RELO relocated items
NICN not in contract
PHS1-9 phase numbers (1-9)
General Rules about Names and Uses

Layer uses are generally implied by the layer name. However, the following explanation of certain layer use rules should be noted.

Status Field / Dominant Phase Rule:
This rule pertains to the use of the status field in naming layers for construction projects, and is defined by the 1997 AIA CAD Layer Guidelines, page 14. It states that layers representing the dominant phase of a project can be represented without a status field.
For example, in a small remodeling project, NEWW would indicate new construction, while layers without status fields would indicate parts of the existing building to remain. Conversely, a remodeling project consisting of mostly new construction might use EXST to indicate “existing to remain” building systems while all layers without a status field designator would represent new construction.

Annotation and Title Blocks:
These rules also come from the 1997 AIA CAD Layer Guidelines, which define annotation as comprising text, dimensions, title block and sheet borders, detail references and other elements on CAD drawings that do not represent physical aspects of a building. Annotation is designated by the major group ANNO, which can be combined with any discipline code. Types of annotation are designated below (asterisk represents any discipline code):

*-ANNO-DIMS dimensions
*-ANNO-KEYN keynotes
*-ANNO-LEGN legends and schedules
*-ANNO-NOTE notes
*-ANNO-NPLT construction lines, nonplotting information, viewports
*-ANNO-REDL redlines
*-ANNO-REVS revisions
*-ANNO-SYMB symbols
*-ANNO-TEXT text
*-ANNO-TTLB title blocks and sheet borders

Annotation can be placed in both model space and paper space (see Policy on Model Space and Paper Space). Dimensions, symbols and keynotes would typically be placed in model space. Legends, schedules, title blocks, and sheet borders would typically be placed in paper space. The same layer names would be used in both cases.

Elevations, Sections, and Three-Dimensional Drawings:
Per the 1997 AIA CAD Layer Guidelines, special groups of layers within each discipline are defined for elevations, section, details, and three-dimensional views. Defined layer groups are as follows (asterisk represents any discipline code):

*-ELEV elevations
*-ELEV-IDEN component identification numbers
*-ELEV-OTLN building outlines
*-ELEV-PATT textures and hatch patterns
*-SECT sections
*-SECT-MBND materials beyond section cut
*-SECT-MCUT materials cut by section
*-SECT-PATT textures and hatch patterns
*-SECT-IDEN component identification numbers
*-DETL details
*-DETL-IDEN component identification numbers
*-DETL-MBND material beyond section cut
*-DETL-MCUT material cut by section
*-DETL-PATT textures and hatch patterns

AIA guidelines further recommend that the minor group ELEV can be added to any major group layer (A-WALL-ELEV, A-DOOR-ELEV, etc.) to identify information only seen in 3D views. This facilitates integrating three-dimensional CAD models with two-dimensional plans, as shown by this example:
A-WALL walls in plan view
A-WALL-ELEV wall surfaces in 3D view

**NYPH Defined Layers and Discipline Category:**
NYPH has defined a short list of layers designated for space management uses which should be employed in conjunction with facility documentation projects. These layers need not be used for construction projects. All NYPH defined layers can be found appended to the partial AIA layer list included with this document under the discipline code U (for New York Presbyterian Hospital use).

**Core Layers:**
Approximately 25 core layers have been identified by a diamond symbol (♦) in the *Standard Layer Listing* for use by Preferred CAD Vendors producing facility documentation drawings. These layers may also be used for producing construction drawings, when applicable. Depending on the NYPH faculty or department requesting facility documentation drawings, the core layer list and attributes of core layers may vary somewhat from project to project. In this case, see your NYPH client representative for preferences.

**Attributes**

Many of the layers found in the partial AIA layer list in the *Standard Layer Listing* have been assigned specific attribute values by NYPH according to the following categories: color, pen weight, and linetype. Attributes that have not been pre-defined by NYPH may be assigned at the discretion of the user.

**Linetypes**
The default linetype of each layer is typically CONTINUOUS unless otherwise specified.

**Colors**
NYPH recommends the use of specific colors for core layers and annotation layers only (see the previous section regarding the definition of core layers). The color assignment of these layers can be found in the *Standard Layer Listing*. All other layers must have their colors assigned at the discretion of users.

As a general rule for all projects, drawing entities should assume the color property of the layer on which they reside. This means that the color of individual entities should be assigned ‘by layer’ as opposed to ‘by entity.’ Entities which have been translated from non-AutoCAD based CAD systems often fail to meet this requirement.

Color specifications for facility documentation projects may vary according to the preferences of NYPH departments requesting drawings. In this case, see your NYPH client representative for additional instructions.

**Pen Weight**
The following chart shows pen weight assignments which should maximize the printed clarity of drawings conforming to the color assignments of NYPH’s core layers. Other pen weights must be assigned at the discretion of each user.

Preferred CAD vendors producing facility drawings should consult your NYPH client representative for preference variations.

Pen #, Color, Weight, Core drawing elements (including, but not limited to):
1. red, .010, furniture, casement, fixed/moveable equipment
2. yellow, .010, stairs details, elevator cars, toilet partitions, partial height walls
3. green, .012, toilets, sinks, bathtubs, showers
4. cyan, .012, text, dimensions, legends, etc, NYPH room polylines
5. blue, .010, NYPH space tracking room numbers
6. magenta, .016, structural columns, NYPH gross floor polylines
7. white, .026, walls, exterior
8. dk, grey, .012
9. lt grey, .016, walls, interior (except partial height walls)
30. orange, .025
50. tan, .035
FILE NAME CONVENTIONS

As explained in the following section entitled Policy on Model Space and Paper Space, NYPH requires that each CAD file submitted as a project deliverable contain only one drawing model with one title block. This policy allows each CAD file produced for either a facility documentation project or a construction project to be named according to the conventions outlined below. Without counting the file extension, CAD file names must not exceed 10 characters in length.

Naming Facility Documentation Drawings (primary method)-
CAD files produced by Preferred CAD Vendors which typically contain drawings of existing facility conditions should be named according to the following formula:

file name = building ID code + floor ID code
format = 2 character + 3 characters

EXAMPLES:
GP-01.dwg = Building Code GP (Greenberg Pavilion) + First Floor #01
ST-00.dwg = Building Code ST (Starr Building) + Sub-Basement #01

Building ID Code.
The standard NYPH building identification code assigned by Facilities Department is normally a two character code. Please contact your NYPH representative for the standard building identification codes that pertain to your project.

Floor ID Code.
The standard floor identification code follows a two digit numbering system. Floors above or at grade are numbered sequentially in ascending order, starting with 01, 02, 03, etc. Floors that are below grade are numbered with zeros, starting with 0 (basement), 00, (sub-basement), 000, (sub-sub-basement).

Naming Facility Documentation Drawings (secondary method)-
Facility documentation drawings related to a specific building industry discipline or depicting a specific type of drawing other than a typical existing conditions floor plan may be named using either one of the formulas below. When using these formulas, the building ID codes and the floor ID codes should follow the same rules described above, and the discipline code and drawing type codes should be assigned according to the values listed in the following section for use with construction drawings.

file name = building ID code + floor ID code + discipline code
format = 2 character + 3 characters + 1 character

EXAMPLES:
GP-01A.dwg = Building Code GP (Greenberg Pavilion) + First Floor 01 + Architectural code A
ST-00F.dwg = Building Code ST (Starr Building) + Sub-Basement 00 + Fire Protection code F

-- or --
file name = building ID code + floor ID code (optional) + drawing type code
format = 2 character + 3 characters + 2 characters

EXAMPLES:
GP-01QP.dwg = Building Code GP (Greenberg Pavilion) + First Floor #01 + Equipment Plan code QP
ST-EL.dwg = Building Code ST (Starr Pavilion) + Elevation drawing code EL

Naming Construction Drawings -
It is suggested that architects, engineers and contractors use the file naming convention shown below, which follows the Naming Model Files section of the 1997 American Institute of Architects’ CAD Layer Guidelines document.

(Important Note: Do NOT use the AIA recommendation Naming Sheet Files, as NYPH requests that titleblocks and model files be contained within a single AutoCAD drawing file upon final delivery of project files to NYPH. See section entitled Policy on Model Space and Paper Space for further explanation.)
file name = discipline code + drawing type code + drawing number
format = 1 character + 2 characters + 2 characters

EXAMPLE:
S-SC01.dwg = structural code S- + site plan code SC + first drawing, number 01

**Discipline Codes:**

A- Architectural
C- Civil
E- Electrical
F- Fire Protection
G- General
H- Hazardous Materials
I- Interiors
L- Landscape
M- Mechanical
P- Plumbing
Q- Equipment
S- Structural
T- Telecommunications
U- New York Presbyterian Hospital (NYPH defined)
W- Space Management
X- Other Disciplines
Z- Contractor / Shop drawings

**Drawing Type Codes that apply to all disciplines** (where *- represents any discipline code):

*EL Elevation
*SP Site Plan
*SC Section
*DP Demolition Plan
*DT Detail
*QP Equipment Plan
*SH Schedule
*EX Existing Plan
*3D Isometric/3D
*DG Diagrams

**Drawing Type Codes (specific to a particular discipline):**

**Architectural**
A-CP Reflected Ceiling Plan
A-EP Enlarged Plan
A-FN Finish Plan
A-FP Furniture Plan
A-RP Renovation Plan
A-CD Construction Plan

**Space Management**
W-BP Blocking Plan
W-XD Room Inventory (AFM)

**Civil**
C-EV Environmental
C-GR Grading
C-RT Roads/Topographic
C-SV Survey
C-UP Utility

**Mechanical**
M-CT Control Plan
M-HP HVAC Ductwork Plan
M-PP Piping Plan
**Electrical**
E-CM Communication
E-LP Lighting Plan
E-GP Grounding
E-PW Power Plan

**Plumbing**
P-PL Plumbing Plan

**Structural**
S-FR Framing Plan
S-FD Foundation Plan

**Fire Protection**
F-VP Evacuation Plan
F-KP Sprinkler Plan

**Telecommunications**
T-DA Data
T-TP Telephone

**Drawing Number.**
The drawing number is the number of the drawing as it falls into a sequential set. If there are five architectural furniture plans in the set, then the first drawing is AFP01.dwg and the fifth drawing is AFP05.dwg
POLICY on CAD FILE TRANSLATION

Error-free AutoCAD Drawing Deliverables:
New York Presbyterian Hospital recognizes that many of its construction and facility documentation service providers do not use the same CAD systems as the Hospital. However, the Hospital expects that service providers who work with non-AutoCAD file formats will submit DWG formatted CAD files upon project closeout that are fully compliant with all of the standards outlined herein, and which have no significant loss of drawing entities or project data that can result from standard CAD file translation procedures.

All DWG files and CAD drawing entities submitted at the end of a project must be able to be manipulated using standard AutoCAD drafting procedures. Non-compliance with this policy may result in the rejection of CAD files submitted at project closeout in addition to delayed rendering of final project payment. DXF files will not be accepted at project closeout as a substitution for DWG CAD file deliverables.

Translation Testing Recommended:
For firms translating their native CAD file format into AutoCAD format also concerned about delivering error-free CAD files to NYPH upon project closeout, it is strongly recommended that thorough file translation testing be conducted before the drawing development phase of the project. This will assure early detection of file conversion issues, if any, and allow for corrective measures to be taken before the project closeout period.
### ELECTRICAL SIGN-OFF FORMS (FINAL)

**NEW YORK PRESBYTERIAN HOSPITAL**

{PROJECT NAME:}

**DATE OF INSPECTION:**

**INSPECTED BY:**

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<td>D</td>
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New York Presbyterian Hospital
Engineering Design Standards

Appendix
February 1, 2000
## ELECTRICAL SIGN-OFF FORMS (FINAL)

**NEW YORK PRESBYTERIAN HOSPITAL**  
**PROJECT NAME:**  
**DATE OF INSPECTION:**  
**INSPECTED BY:**

**LOAD CENTER DESIGNATION:**

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New York Presbyterian Hospital  
Engineering Design Standards  
Appendix  
February 1, 2000
## Electrical Sign-off Forms (Final)

**NEW YORK PRESBYTERIAN HOSPITAL**

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## ELECTRICAL SIGN-OFF FORMS (FINAL)

**NEW YORK PRESBYTERIAN HOSPITAL**

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<tr>
<td>Lamps installed</td>
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<tr>
<td>Light switch installed</td>
<td>□ YES □ NO</td>
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<td>Duplex receptacle installed</td>
<td>□ YES □ NO</td>
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<td>Device coverplates installed</td>
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<td>Fire Sealing installed</td>
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#### BUSDUCT #1

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<td>Characteristics</td>
<td>□ Normal □ Normal - Equipment</td>
<td>□ EM-CR □ Ener. - Equipment</td>
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<td>Connections to busduct devices</td>
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<td>□ N/A</td>
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<td>Laminoid Labels on Switches</td>
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<tr>
<td>Spring Mounts</td>
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<tr>
<td>Curb @ floor</td>
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### Electrical Sign-Off Forms (Final)

**NEW YORK PRESBYTERIAN HOSPITAL**

**PROJECT NAME:**

**DATE OF INSPECTION:**

**INSPECTED BY:**

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<td><strong>Lamroid Labels on Switches</strong></td>
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<td>□ YES □ NO</td>
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<td><strong>Spring Mounts</strong></td>
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New York Presbyterian Hospital
Engineering Design Standards

Appendix
February 1, 2000
### ELECTRICAL SIGN-OFF FORMS (FINAL)

**NEW YORK PRESBYTERIAN HOSPITAL**  
{PROJECT NAME:}  
DATE OF INSPECTION: 11.10.99  
INSPECTED BY: PDJ

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<td>[ ] Other</td>
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<td></td>
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<tr>
<td>Smoke Detectors Installed</td>
<td>[ ] YES</td>
<td>[ ] NO</td>
<td></td>
</tr>
<tr>
<td>Condition of Enclosure Finishes</td>
<td>[ ] GOOD</td>
<td>[ ] POOR</td>
<td></td>
</tr>
<tr>
<td>General Cleanliness</td>
<td>[ ] CLEAN</td>
<td>[ ] DIRTY</td>
<td></td>
</tr>
<tr>
<td>Door Signage (Room #)</td>
<td>[ ] YES</td>
<td>[ ] NO</td>
<td></td>
</tr>
</tbody>
</table>
NYPH Equipment and Device Standards

Equipment No. MSI

To ensure that an accurate and up-to-date equipment inventory is maintained and a means of identifying same is in place, the following guidelines shall be in effect for all New York - Presbyterian Hospital sites, and be the sole responsibility of the MEP contractor.

A unique equipment number is assigned to each piece of equipment that requires maintenance. This unique equipment number is referred to as the MSI (Maintenance Significant Item) number.

The MSI number shall be established by the Engineer in coordination with the Contractor during the Shop Drawing Development Stage.

An MSI number is not limited to a single piece of equipment (regular MSI). It shall also be assigned to groups of maintainable items or locations (general MSI). The two types of MSIs are defined as follows:

The regular MSI is assigned to specific pieces of equipment such as electrical equipment, switches, pumps, heat exchangers, and air handling units.

The general MSI is assigned to groups of equipment or areas of a building such as interior architectural features, roofs, plumbing fixtures and lighting fixtures.
The structure of the MSI number for NewYork-Presbyterian Hospital will consist of five (5) sets of characters in the following format:

**VWW-XXX-YZZ**

The first character (VWW-XXX-YZZ) identifies the NewYork-Presbyterian Hospital site where the equipment is located. Sites are designated as follows:

<table>
<thead>
<tr>
<th>Site</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>NewYork Presbyterian Hospital - Cornell Campus</td>
<td>N</td>
</tr>
<tr>
<td>New York Presbyterian Hospital Cornell Westchester Division</td>
<td>W</td>
</tr>
<tr>
<td>International Center for the Disabled</td>
<td>I</td>
</tr>
<tr>
<td>NewYork-Presbyterian Hospital - Columbia Campus</td>
<td>P</td>
</tr>
<tr>
<td>New York Presbyterian Hospital Queens</td>
<td>Q</td>
</tr>
</tbody>
</table>

The second and third characters (VWW-XXX-YZZ) identifies the specific building within the site. Buildings are designated as follows:

<table>
<thead>
<tr>
<th>Site/Building</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>NewYork Presbyterian-Hospital - Cornell Campus</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Building</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Hospital</td>
<td>F</td>
</tr>
<tr>
<td>Greenberg</td>
<td>G</td>
</tr>
<tr>
<td>Annex/Powerhouse</td>
<td>AN</td>
</tr>
<tr>
<td>Connie Guion</td>
<td>J</td>
</tr>
<tr>
<td>K Building</td>
<td>K</td>
</tr>
<tr>
<td>L Building</td>
<td>L</td>
</tr>
<tr>
<td>Lying-in Hospital</td>
<td>M</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>N</td>
</tr>
<tr>
<td>Payson</td>
<td>P</td>
</tr>
<tr>
<td>Stich Building</td>
<td>SC</td>
</tr>
<tr>
<td>C.V. Starr</td>
<td>ST</td>
</tr>
<tr>
<td>N 36-21Vernon Blvd. Parking Garage.</td>
<td>VR</td>
</tr>
<tr>
<td>Whitney</td>
<td>W</td>
</tr>
<tr>
<td>21-36 21st L.I.C. Family Center</td>
<td>21</td>
</tr>
<tr>
<td>333 E. 38th Street.</td>
<td>38</td>
</tr>
<tr>
<td>401 East 71st Meth Center.</td>
<td>61</td>
</tr>
<tr>
<td>425 East 61st Street.</td>
<td>71</td>
</tr>
<tr>
<td>505 E 70th Helmsley Tower.</td>
<td>HT</td>
</tr>
<tr>
<td>Anatomy (Harkness)</td>
<td>A</td>
</tr>
<tr>
<td>Bacteriology CUMC</td>
<td>B</td>
</tr>
<tr>
<td>Path. 1300 York Ave.</td>
<td>C</td>
</tr>
<tr>
<td>Physiology CUMC</td>
<td>D</td>
</tr>
<tr>
<td>Pharmacology CUMC</td>
<td>E</td>
</tr>
<tr>
<td>Kips Bay Clinic CUMC</td>
<td></td>
</tr>
</tbody>
</table>

Cornell University Medical Center (CUMC).......................... C

<table>
<thead>
<tr>
<th>Building</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomy (Harkness)</td>
<td>A</td>
</tr>
<tr>
<td>Bacteriology CUMC</td>
<td>B</td>
</tr>
<tr>
<td>Path. 1300 York Ave.</td>
<td>C</td>
</tr>
<tr>
<td>Physiology CUMC</td>
<td>D</td>
</tr>
<tr>
<td>Pharmacology CUMC</td>
<td>E</td>
</tr>
<tr>
<td>Kips Bay Clinic CUMC</td>
<td></td>
</tr>
<tr>
<td>Lasdon Building LBRC</td>
<td>LC</td>
</tr>
<tr>
<td>Harkness CUMC</td>
<td>R</td>
</tr>
<tr>
<td>S Building CUMC</td>
<td>S</td>
</tr>
</tbody>
</table>

NewYork-Presbyterian Hospital Engineering Design Standards

Appendix

February 1, 2000
NewYork-Presbyterian Hospital - Columbia Campus

<table>
<thead>
<tr>
<th>Code</th>
<th>Location</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>P35</td>
<td>135th Street Clinic</td>
<td>Eye Addition</td>
</tr>
<tr>
<td>P58</td>
<td>158th Street Garage</td>
<td>Energy Court</td>
</tr>
<tr>
<td>P80</td>
<td>180th Street Garage</td>
<td>Eye Institute</td>
</tr>
<tr>
<td>PAL</td>
<td>Allen Pavilion</td>
<td>Eye Reasearch</td>
</tr>
<tr>
<td>PAP</td>
<td>Atchley Pavilion</td>
<td>FW</td>
</tr>
<tr>
<td>PAU</td>
<td>Audubon</td>
<td>Harkness Pavillion</td>
</tr>
<tr>
<td>PBN</td>
<td>Babies Hospital - North</td>
<td>Milstein Hospital Building</td>
</tr>
<tr>
<td>PBS</td>
<td>Babies Hospital - South</td>
<td>Neurological Insitute</td>
</tr>
<tr>
<td>PBA</td>
<td>Babies Hospital - North Addition</td>
<td>Presbyterian Hospital</td>
</tr>
<tr>
<td>PBR</td>
<td>Black Building, Boiler Room</td>
<td>Resource Center</td>
</tr>
<tr>
<td>PBW</td>
<td>Broadway</td>
<td>Service Building</td>
</tr>
<tr>
<td>PDC</td>
<td>Day Care Center</td>
<td>Vanderbilt Clinic</td>
</tr>
</tbody>
</table>

NewYork-Presbyterian Hospital - Cornell/Westchester Division

<table>
<thead>
<tr>
<th>Location</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-North</td>
<td>N01</td>
</tr>
<tr>
<td>1-South</td>
<td>S01</td>
</tr>
<tr>
<td>12-North</td>
<td>N12</td>
</tr>
<tr>
<td>12-South</td>
<td>S12</td>
</tr>
<tr>
<td>145 Westchester Ave</td>
<td>145</td>
</tr>
<tr>
<td>2-North</td>
<td>N02</td>
</tr>
<tr>
<td>2-South</td>
<td>S02</td>
</tr>
<tr>
<td>3-North</td>
<td>N03</td>
</tr>
<tr>
<td>3-South</td>
<td>S03</td>
</tr>
<tr>
<td>3A-North</td>
<td>N3A</td>
</tr>
<tr>
<td>3A-South</td>
<td>S3A</td>
</tr>
<tr>
<td>4-5-6 South</td>
<td>S45</td>
</tr>
<tr>
<td>4-5-6 North</td>
<td>N45</td>
</tr>
<tr>
<td>4-5-6 North</td>
<td>N46</td>
</tr>
<tr>
<td>4-5-6 North</td>
<td>N47</td>
</tr>
<tr>
<td>4-North</td>
<td>N04</td>
</tr>
<tr>
<td>4-South</td>
<td>S04</td>
</tr>
<tr>
<td>5-North</td>
<td>N05</td>
</tr>
<tr>
<td>5-South</td>
<td>S05</td>
</tr>
<tr>
<td>6-North</td>
<td>N06</td>
</tr>
<tr>
<td>6-South</td>
<td>S06</td>
</tr>
<tr>
<td>6A North</td>
<td>N6A</td>
</tr>
<tr>
<td>6A-South</td>
<td>S6A</td>
</tr>
<tr>
<td>7-8 South</td>
<td>S78</td>
</tr>
<tr>
<td>7-8 North</td>
<td>N78</td>
</tr>
<tr>
<td>7-North</td>
<td>N07</td>
</tr>
<tr>
<td>7-South</td>
<td>S07</td>
</tr>
<tr>
<td>8-North</td>
<td>N08</td>
</tr>
<tr>
<td>8-South</td>
<td>S08</td>
</tr>
<tr>
<td>8A-North</td>
<td>N8A</td>
</tr>
<tr>
<td>8A-South</td>
<td>S8A</td>
</tr>
<tr>
<td>Banker Villa</td>
<td>ASS</td>
</tr>
<tr>
<td>Banker Utility Tunnel</td>
<td>BKT</td>
</tr>
<tr>
<td>Bard House</td>
<td>BAR</td>
</tr>
<tr>
<td>Bard House</td>
<td>BAN</td>
</tr>
<tr>
<td>Boiler Room</td>
<td>BR</td>
</tr>
<tr>
<td>Bourne Lab</td>
<td>BOU</td>
</tr>
<tr>
<td>Brown Villa</td>
<td>BRO</td>
</tr>
<tr>
<td>Bruce House</td>
<td>BRU</td>
</tr>
<tr>
<td>Butchers Shop</td>
<td>BUT</td>
</tr>
<tr>
<td>Cafeteria Building</td>
<td>CAF</td>
</tr>
<tr>
<td>Campbell Cottege</td>
<td>CC</td>
</tr>
<tr>
<td>Canteen</td>
<td>CAN</td>
</tr>
<tr>
<td>Carpenter Shop</td>
<td>CAR</td>
</tr>
<tr>
<td>Center Compartment</td>
<td>XXX</td>
</tr>
<tr>
<td>Center Building</td>
<td>CEN</td>
</tr>
<tr>
<td>Coal Storage Area</td>
<td>CSA</td>
</tr>
<tr>
<td>Computer Services</td>
<td>IS</td>
</tr>
<tr>
<td>Cottage 12A</td>
<td>12A</td>
</tr>
<tr>
<td>Cottage 05</td>
<td>C05</td>
</tr>
<tr>
<td>Cottage 09</td>
<td>C09</td>
</tr>
<tr>
<td>Cottage 06</td>
<td>C06</td>
</tr>
<tr>
<td>Cottage 10</td>
<td>C10</td>
</tr>
<tr>
<td>Cottage 08</td>
<td>C08</td>
</tr>
<tr>
<td>Cottage 07</td>
<td>C07</td>
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<td>Cottage 04</td>
<td>C04</td>
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<tr>
<td>Cottage 01</td>
<td>C01</td>
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<tr>
<td>Cottage 03</td>
<td>C03</td>
</tr>
<tr>
<td>Cottage 02</td>
<td>C02</td>
</tr>
<tr>
<td>Cottage 11</td>
<td>C11</td>
</tr>
<tr>
<td>Cottage 12</td>
<td>C12</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Data Processing</td>
<td>DP</td>
</tr>
<tr>
<td>Education School Annex</td>
<td>ESA</td>
</tr>
<tr>
<td>Electrical Shop</td>
<td>ELE</td>
</tr>
<tr>
<td>Emergency Gen. Room</td>
<td>GEN</td>
</tr>
<tr>
<td>Employee Garage</td>
<td>EG</td>
</tr>
<tr>
<td>Farm House</td>
<td>FAR</td>
</tr>
<tr>
<td>Gas Meter House</td>
<td>GAS</td>
</tr>
<tr>
<td>Green House</td>
<td>GH</td>
</tr>
<tr>
<td>Grounds Garage</td>
<td>GRD</td>
</tr>
<tr>
<td>Hall-H-Medical Records</td>
<td>MR</td>
</tr>
<tr>
<td>High Voltage Vaults</td>
<td>HV</td>
</tr>
<tr>
<td>Hortz House</td>
<td>HOL</td>
</tr>
<tr>
<td>House 10</td>
<td>H10</td>
</tr>
<tr>
<td>Lake Pump House</td>
<td>LPH</td>
</tr>
<tr>
<td>Macy Utility Tunnel</td>
<td>M UT</td>
</tr>
<tr>
<td>Macy Villa</td>
<td>MAC</td>
</tr>
<tr>
<td>Main Kitchen</td>
<td>MK</td>
</tr>
<tr>
<td>Main Store Room</td>
<td>SR</td>
</tr>
<tr>
<td>Mechanics Cottage</td>
<td>MEC</td>
</tr>
<tr>
<td>Medical Library</td>
<td>LIB</td>
</tr>
<tr>
<td>Nichols Cottage Basement</td>
<td>NCB</td>
</tr>
<tr>
<td>Nichols Cottage Office</td>
<td>NCO</td>
</tr>
<tr>
<td>Nichols Cottage</td>
<td>NC</td>
</tr>
<tr>
<td>North Tunnel</td>
<td>NT</td>
</tr>
<tr>
<td>North Street Cottage</td>
<td>NSC</td>
</tr>
<tr>
<td>Office</td>
<td>OFF</td>
</tr>
<tr>
<td>Old Boiler Room</td>
<td>OBR</td>
</tr>
</tbody>
</table>

International Center for the Disabled ............................ ICD

NewYork-Presbyterian Hospital Queens ............................. Q

XXXXX ................................................................. X

XXXXX ................................................................. X

Characters four through six (UVV-XXX-YZZ) identify the equipment type or category. The equipment type is the most important part of the MSI number because PM procedures are assigned based on the equipment type. The following list contains examples of regular and general MSI equipment types. A listing of valid equipment types shall come from the NYP Hospital Facilities Standards Manual.

**Equipment Type Description .............................................. Equipment Type**

**Regular MSI:**

**Air Handling Unit** .................................................. AHU

**Chiller** .............................................................. CH

**Boiler** ............................................................... B

NewYork-Presbyterian Hospital Engineering Design Standards

Appendix

February 1, 2000
The seventh digit (VWW-XXX-YZZ) is used to define the floor that the equipment is located on. Floor designations are:

<table>
<thead>
<tr>
<th>Floor Designation</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Sub Basement</td>
<td>3</td>
</tr>
<tr>
<td>Sub-Basement</td>
<td>2</td>
</tr>
<tr>
<td>Basement</td>
<td>1</td>
</tr>
<tr>
<td>1st Floor</td>
<td>A</td>
</tr>
<tr>
<td>2nd Floor</td>
<td>B</td>
</tr>
<tr>
<td>3rd Floor</td>
<td>C</td>
</tr>
<tr>
<td>4th Floor</td>
<td>D</td>
</tr>
<tr>
<td>5th Floor</td>
<td>E</td>
</tr>
<tr>
<td>6th Floor</td>
<td>F</td>
</tr>
<tr>
<td>7th Floor</td>
<td>G</td>
</tr>
<tr>
<td>8th Floor</td>
<td>H</td>
</tr>
<tr>
<td>9th Floor</td>
<td>I</td>
</tr>
<tr>
<td>10th Floor</td>
<td>J</td>
</tr>
<tr>
<td>11th Floor</td>
<td>K</td>
</tr>
<tr>
<td>12th Floor</td>
<td>L</td>
</tr>
<tr>
<td>13th Floor</td>
<td>M</td>
</tr>
<tr>
<td>14th Floor</td>
<td>N</td>
</tr>
<tr>
<td>15th Floor</td>
<td>O</td>
</tr>
<tr>
<td>16th Floor</td>
<td>P</td>
</tr>
<tr>
<td>17th Floor</td>
<td>Q</td>
</tr>
<tr>
<td>18th Floor</td>
<td>R</td>
</tr>
<tr>
<td>19th Floor</td>
<td>S</td>
</tr>
<tr>
<td>20th Floor</td>
<td>T</td>
</tr>
<tr>
<td>21st Floor</td>
<td>U</td>
</tr>
<tr>
<td>22nd Floor</td>
<td>V</td>
</tr>
<tr>
<td>23rd Floor</td>
<td>W</td>
</tr>
<tr>
<td>24th Floor</td>
<td>X</td>
</tr>
<tr>
<td>25th Floor or Roof</td>
<td>Y</td>
</tr>
<tr>
<td>26th Floor or Penthouse</td>
<td>Z</td>
</tr>
<tr>
<td>Entire Building</td>
<td>0</td>
</tr>
</tbody>
</table>

The eighth and ninth digits (UVV-XXX-YZZ) represent the piece number and are used to increment the equipment type designation (i.e., 01, 02, 03). The piece number is usually related to the equipment design number.

(e.g., PM-AHU-J03 is the MSI number for air handling unit AHU-3 located on the 10th floor (J) of the Milstein Hospital Building, New York Presbyterian Hospital - Columbia Campus.)

General MSI:
Sprinkler System ................................................... SPR
Fire Alarm System .................................................. FAS

(e.g., NG-SPR-00A is the general MSI number for Zone A sprinkler system in the Greenberg Building, New York Presbyterian Hospital 68th street.)
These equipment labels will indicate the equipment number, the equipment designation, the system and a bar code indicating the equipment number. The bar code will allow an interface between the equipment and a portable bar code reader. These equipment labels will be installed by S&H.

- **Material**
Labels shall be made of 1/8" thick laminated plastic material.

- **Size**
There shall be two sizes of labels:
  - 8-1/2" x 11" To be used on larger equipment such as Air Handlers and Chillers
  - 2-5/8"x3-3/4" To be used for smaller equipment such as Electrical Panels and Pumps.

- **Application**
Labels shall be attached to equipment with sheet metal screws were applicable. Where this type of application is not possible, then labels shall be applied with extra strength spray adhesive or approved equal where applicable. 2-5/8" x 3-3/4" labels shall be installed on local disconnect. 8-1/2" x 11" tags shall be installed in a location where they will be highky visible from unit disconnect.

- **Color**
Equipment labels shall be provided in two colors:
  - Yellow: Which shall indicate that the equipment is connected to a normal power source (No emergency power source).
  - Red: Which shall indicate that the equipment is connected to an emergency power source.

- **Barcode**
Barcode shall represent the MSI number and have a minimum of nine characters including spaces. Barcode shall also be in Code39 format. Barcode shall be 2-3/8"-2-3/4" on the large label and 1-3/8" x 1/4" on the small label. Barcode shall be Rowmark™ or approved equal.

- **Content**
Each labels shall contain the following information:
  - MSI Number in Code 39 Barcode format.
    Located in the upper left hand corner of the tag, this information is provided so that hand held scanning devices can be used.
  - Primary trade of the Equipment
    Consisting of a four letter abbreviation of the trade and located in the upper right hand corner of the tag, this information designates primary trade of the equipment. (e.q.: HVAC, ELEC, PLUM)
- Equipment ID (MSI Number)
  Located towards the middle of the tag, in large print, this is the Equipment identification number.

- Description of the equipment
  This information describes the equipment (e.g.: Air Handling Unit, Boiler Feed Pump, Chiller, etc.)

- Parent
  Where applicable, this information defines an associated equipment. (e.g.: The parent a chilled water pump would be the associated Chiller, the parent for a Low Voltage Power Panel 480Y/277 would be the associated Distribution Power Panel 480Y/277). This field is optional and may not apply to all equipment.

- Design Number
  This field allows for a Design Number to be assigned to a piece of equipment in addition to MSI number. This number is normally reserved for electrical equipment where a separate numbering scheme may prove beneficial to the design of an electrical system. When referenced on construction documents, this information is to be provided.

- System
  This information indicates the system that the equipment is part of. (e.g: Return Fan PM - RAF-J09 is Part of Air Handling System PM-AHU-J09.

- Power From
  This information indicates the MSI number of the Electrical Panel and the respective circuit number that feeds the equipment.

Format
The format of the Equipment Labels shall be:

<table>
<thead>
<tr>
<th>Equipment ID:</th>
<th>PM-AHU-J10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Air Handling Unit No. 1</td>
</tr>
<tr>
<td>Design Number:</td>
<td>AC-1</td>
</tr>
<tr>
<td>System:</td>
<td>Air Handling System PM-AHU-J10</td>
</tr>
<tr>
<td>Power From:</td>
<td>PM-PH-J16, Circuit No. 22</td>
</tr>
</tbody>
</table>
Air Handling Unit
Acceptance Test Form

DATE: ____________________________  NYPH: ____________________________

UNIT: ____________________________  CONTRACTOR: ________________

ENGINEER: ________________

☐ Passed  ☐ Failed

1. Damper Actuator Check Out  ☐ Complete  ☐ Incomplete
   • Command Damper actuators to 0%, 5% and 100% positions and verify if they are controlling correctly.
   • If dampers do not actuate properly, then increase the PSI input until you reach the desired position.
   • When completed, note the new spring range for each damper on the attached blank form.
   • If incomplete, note problems encountered on the attached blank form.

2. Valve Actuator Check Out  ☐ Complete  ☐ Incomplete
   • Command all applicable valve actuators, e.g., pre-heat, humidity, and chilled water to 0%, 5% and 100% positions and verify if they are controlling correctly.
   • Mark the stem of the actuators as you reach each position.
   • If valve actuators do not actuate properly, then increase the PSI input until you reach the desired position.
   • When completed, note the new spring range for each valve on the attached blank form.
   • If incomplete, note problems encountered on the attached blank form.
3. **Temperature Sensors**

- Through the PC verify all sensors are operating and not in alarm.
- Place a temp probe next to a temperature sensor and compare your readings with the PC’s reading.
- If incomplete, note the sensors that are not working properly on the attached blank form.

4. **Static Pressure Sensors (If Applicable)**

- Install your static pressure probe “Magnehelic or Solomat” in parallel with the static pressure transmitter or Magnehelic.
- Compare your readings with the PC’s.
- If readings are different adjust the device.
- If incomplete, note problems encountered on the attached blank form.

5. **Freeze Safety Checkout**

- Check the actual Freeze Status switch.
- Press the reset button on the face of the switch.
- Verify that the fan shuts down.
- Release reset button and watch the fan return to normal.
- If incomplete, note problems encountered on the attached blank form.

6. **HI and LOW Pressure Switch Checkout (If Applicable)**

- While fan is running, trip each switch one at a time.
- Verify that the fan shuts down.
- Then reset the switches and verify that the fan restarts.
- If incomplete, note problems encountered on the attached blank form.

7. **Verifying Start/Stop Operation of the AHU**

- Command fan to Stop.
- Verify fan status is Off.
- Verify dampers are Closed.
- Verify all valves are at their normal positions.

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Appendix
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8. Normal Temperature Control

- Command fan to Start.
- Verify fan status is On.
- Verify dampers are Open.
- If incomplete, note problems encountered on the attached blank form.

- Verify that the dampers, preheat valves and valve operate in sequence to maintain the desired supply temperature setpoint.