# UNIVERSITY OF OREGON ERB MEMORIAL UNION
## ADDITION AND RENOVATION - PACKAGE 4

**PROJECT NO. 11045**  
2013.12.20

### TABLE OF CONTENTS

#### DIVISION 00 PROCUREMENT AND CONTRACTING REQUIREMENTS
- 00 01 10 TABLE OF CONTENTS
- 00 31 00 AVAILABLE PROJECT INFORMATION

#### DIVISION 01 GENERAL REQUIREMENTS
- 01 10 00 SUMMARY
- 01 20 00 PRICE AND PAYMENT PROCEDURES
  - ARCHITECTURAL BULLETIN
- 01 26 13 REQUEST FOR INTERPRETATION
  - SERA RFI FORM
- 01 30 00 ADMINISTRATIVE REQUIREMENTS
- 01 32 16 CONSTRUCTION PROGRESS SCHEDULE
- 01 33 00 SUBMITTAL PROCEDURES
  - SERA ELECTRONIC MEDIA RELEASE
- 01 33 16 DELEGATED DESIGN PROCEDURES
- 01 35 15 LEED CERTIFICATION PROCEDURES
  - LEED SCORECARD
- 01 40 00 QUALITY REQUIREMENTS
- 01 43 39 COORDINATED MOCKUPS
- 01 45 19 VAPOR EMISSION AND ALKALINITY TESTING
- 01 50 00 TEMPORARY FACILITIES AND CONTROLS
- 01 56 39 TEMPORARY TREE AND PLANT PROTECTION
- 01 57 13 TEMPORARY EROSION AND SEDIMENT CONTROL
- 01 57 21 INDOOR AIR QUALITY CONTROLS
- 01 60 00 PRODUCT REQUIREMENTS
  - SUBSTITUTION REQUEST FORM
- 01 70 00 EXECUTION AND CLOSEOUT REQUIREMENTS
- 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
- 01 78 00 CLOSEOUT SUBMITTALS
- 01 91 13 GENERAL COMMISSIONING REQUIREMENTS

#### DIVISION 02 EXISTING CONDITIONS
- 02 41 00 DEMOLITION
- 02 83 00 LEAD CONTROL PROCEDURES

#### DIVISION 03 CONCRETE
- 03 30 00 CAST-IN-PLACE CONCRETE
- 03 35 16 HARDENED AND POLISHED CONCRETE
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Division</th>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03 37 13</td>
<td>SHOTCRETE</td>
<td></td>
</tr>
<tr>
<td>03 45 00</td>
<td>PRECAST ARCHITECTURAL CONCRETE</td>
<td></td>
</tr>
<tr>
<td>03 54 00</td>
<td>CAST UNDERLAYMENT</td>
<td></td>
</tr>
<tr>
<td>04 01 20</td>
<td>BRICK VENEER RESTORATION &amp; CLEANING</td>
<td></td>
</tr>
<tr>
<td>04 01 40</td>
<td>STONE RESTORATION &amp; CLEANING</td>
<td></td>
</tr>
<tr>
<td>04 42 00</td>
<td>EXTERIOR STONE CLADDING</td>
<td></td>
</tr>
<tr>
<td>04 20 00</td>
<td>UNIT MASONRY</td>
<td></td>
</tr>
<tr>
<td>04 20 01</td>
<td>MASONRY VENEER</td>
<td></td>
</tr>
<tr>
<td>04 42 00</td>
<td>EXTERIOR STONE CLADDING</td>
<td></td>
</tr>
<tr>
<td>05 12 00</td>
<td>STRUCTURAL STEEL FRAMING</td>
<td></td>
</tr>
<tr>
<td>05 21 00</td>
<td>STEEL JOIST FRAMING</td>
<td></td>
</tr>
<tr>
<td>05 31 00</td>
<td>STEEL DECKING</td>
<td></td>
</tr>
<tr>
<td>05 40 00</td>
<td>COLD-FORMED METAL FRAMING</td>
<td></td>
</tr>
<tr>
<td>05 40 10</td>
<td>COLD-FORMED FURRING ASSEMBLIES</td>
<td></td>
</tr>
<tr>
<td>05 50 00</td>
<td>METAL FABRICATION</td>
<td></td>
</tr>
<tr>
<td>05 51 00</td>
<td>METAL STAIRS</td>
<td></td>
</tr>
<tr>
<td>05 73 00</td>
<td>DECORATIVE METAL RAILINGS</td>
<td></td>
</tr>
<tr>
<td>06 10 00</td>
<td>ROUGH CARPENTRY</td>
<td></td>
</tr>
<tr>
<td>06 15 00</td>
<td>WOOD DECKING</td>
<td></td>
</tr>
<tr>
<td>06 16 53</td>
<td>MOISTURE RESISTANT GYPSUM SHEATHING</td>
<td></td>
</tr>
<tr>
<td>06 18 00</td>
<td>GLUE-LAMINATED CONSTRUCTION</td>
<td></td>
</tr>
<tr>
<td>06 20 00</td>
<td>FINISH CARPENTRY</td>
<td></td>
</tr>
<tr>
<td>06 41 00</td>
<td>ARCHITECTURAL WOOD CASEWORK</td>
<td></td>
</tr>
<tr>
<td>06 42 16</td>
<td>WOOD PANELLING</td>
<td></td>
</tr>
<tr>
<td>06 82 05</td>
<td>FIBERGLASS REINFORCED PLASTIC PANELLING</td>
<td></td>
</tr>
<tr>
<td>07 11 13</td>
<td>BITUMINOUS DAMPPROOFING</td>
<td></td>
</tr>
<tr>
<td>07 13 00</td>
<td>SHEET WATERPROOFING</td>
<td></td>
</tr>
<tr>
<td>07 17 13</td>
<td>BENTONITE PANEL WATERPROOFING</td>
<td></td>
</tr>
<tr>
<td>07 19 00</td>
<td>WATER REPELLENTS</td>
<td></td>
</tr>
<tr>
<td>07 21 00</td>
<td>THERMAL INSULATION</td>
<td></td>
</tr>
<tr>
<td>07 25 00</td>
<td>WEATHER BARRIERS</td>
<td></td>
</tr>
</tbody>
</table>
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>07 41 13</td>
<td>METAL ROOF PANELS</td>
</tr>
<tr>
<td>07 42 13</td>
<td>METAL WALL PANELS</td>
</tr>
<tr>
<td>07 54 00</td>
<td>THERMOPLASTIC MEMBRANE ROOFING</td>
</tr>
<tr>
<td>07 56 00</td>
<td>FLUID APPLIED ROOFING</td>
</tr>
<tr>
<td>07 62 00</td>
<td>SHEET METAL FLASHING AND TRIM</td>
</tr>
<tr>
<td>07 72 00</td>
<td>ROOF ACCESSORIES</td>
</tr>
<tr>
<td>07 81 00</td>
<td>APPLIED FIREPROOFING</td>
</tr>
<tr>
<td>07 81 23</td>
<td>INTUMESCENT MASTIC FIREPROOFING</td>
</tr>
<tr>
<td>07 84 00</td>
<td>FIRESTOPPING</td>
</tr>
<tr>
<td>07 90 05</td>
<td>JOINT SEALERS</td>
</tr>
<tr>
<td>07 95 13</td>
<td>EXPANSION JOINT COVER ASSEMBLIES</td>
</tr>
</tbody>
</table>

### DIVISION 08 OPENINGS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>08 01 52</td>
<td>EXISTING WINDOW MAINTENANCE</td>
</tr>
<tr>
<td>08 11 13</td>
<td>HOLLOW METAL DOORS AND FRAMES</td>
</tr>
<tr>
<td>08 14 16</td>
<td>FLUSH WOOD DOORS</td>
</tr>
<tr>
<td>08 31 00</td>
<td>ACCESS DOORS AND PANELS</td>
</tr>
<tr>
<td>08 33 25</td>
<td>OVERHEAD COILING GRILLES</td>
</tr>
<tr>
<td>08 41 26</td>
<td>ALL-GLASS ENTRANCES AND STOREFRONTS</td>
</tr>
<tr>
<td>08 44 13</td>
<td>ALUMINUM FRAMED CURTAIN WALL</td>
</tr>
<tr>
<td>08 63 00</td>
<td>ALUMINUM FRAMED SKYLIGHTS</td>
</tr>
<tr>
<td>08 71 00</td>
<td>DOOR HARDWARE</td>
</tr>
<tr>
<td></td>
<td>HARDWARE SCHEDULE (NOT INCLUDED)</td>
</tr>
<tr>
<td>08 80 00</td>
<td>GLAZING</td>
</tr>
<tr>
<td>08 83 00</td>
<td>MIRRORS</td>
</tr>
<tr>
<td>08 91 00</td>
<td>LOUVERS</td>
</tr>
</tbody>
</table>

### DIVISION 09 FINISHES

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>09 21 16</td>
<td>GYPSUM BOARD ASSEMBLIES</td>
</tr>
<tr>
<td>09 24 00</td>
<td>PORTLAND CEMENT PLASTERING</td>
</tr>
<tr>
<td>09 30 00</td>
<td>TILING</td>
</tr>
<tr>
<td>09 51 00</td>
<td>ACOUSTICAL CEILINGS</td>
</tr>
<tr>
<td>09 54 26</td>
<td>LINEAR WOOD CEILINGS</td>
</tr>
<tr>
<td>09 64 29</td>
<td>WOOD STRIP AND PLANK FLOORING</td>
</tr>
<tr>
<td>09 65 00</td>
<td>RESILIENT FLOORING</td>
</tr>
<tr>
<td>09 66 23</td>
<td>RESINOUS MATRIX TERRAZZO FLOORING</td>
</tr>
<tr>
<td>09 68 00</td>
<td>CARPETING</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Division</th>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>09 68 13</td>
<td>TILE CARPETING</td>
<td></td>
</tr>
<tr>
<td>09 72 00</td>
<td>WALL COVERINGS</td>
<td></td>
</tr>
<tr>
<td>09 83 11</td>
<td>ACOUSTICAL WALL SYSTEMS</td>
<td></td>
</tr>
<tr>
<td>09 84 00</td>
<td>ACOUSTIC ROOM COMPONENTS</td>
<td></td>
</tr>
<tr>
<td>09 90 00</td>
<td>PAINTING AND COATING</td>
<td></td>
</tr>
<tr>
<td>09 96 00</td>
<td>HIGH-PERFORMANCE COATINGS</td>
<td></td>
</tr>
<tr>
<td><strong>DIVISION 10</strong></td>
<td><strong>SPECIALTIES</strong></td>
<td></td>
</tr>
<tr>
<td>10 11 01</td>
<td>VISUAL DISPLAY BOARDS</td>
<td></td>
</tr>
<tr>
<td>10 21 13.19</td>
<td>PLASTIC TOILET COMPARTMENTS</td>
<td></td>
</tr>
<tr>
<td>10 22 26.33</td>
<td>FOLDING PANEL PARTITIONS</td>
<td></td>
</tr>
<tr>
<td>10 26 01</td>
<td>WALL AND CORNER GUARDS</td>
<td></td>
</tr>
<tr>
<td>10 28 00</td>
<td>TOILET, BATH, AND LAUNDRY ACCESSORIES</td>
<td></td>
</tr>
<tr>
<td>10 44 00</td>
<td>FIRE PROTECTION SPECIALTIES</td>
<td></td>
</tr>
<tr>
<td>10 51 00</td>
<td>LOCKERS</td>
<td></td>
</tr>
<tr>
<td>10 56 17</td>
<td>WALL MOUNTED STANDARDS AND SHELVING</td>
<td></td>
</tr>
<tr>
<td>10 56 39</td>
<td>BICYCLE RACKS</td>
<td></td>
</tr>
<tr>
<td>10 75 00</td>
<td>FLAGPOLES</td>
<td></td>
</tr>
<tr>
<td><strong>DIVISION 11</strong></td>
<td><strong>EQUIPMENT</strong></td>
<td></td>
</tr>
<tr>
<td>11 06 00</td>
<td>STAGE CURTAINS</td>
<td></td>
</tr>
<tr>
<td>11 06 10</td>
<td>STUDIO PIPE GRID</td>
<td></td>
</tr>
<tr>
<td>11 24 16</td>
<td>FALL PROTECTION SYSTEM</td>
<td></td>
</tr>
<tr>
<td>11 31 00</td>
<td>RESIDENTIAL APPLIANCES</td>
<td></td>
</tr>
<tr>
<td>11 52 13</td>
<td>PROJECTION SCREENS</td>
<td></td>
</tr>
<tr>
<td><strong>DIVISION 12</strong></td>
<td><strong>FURNISHINGS</strong></td>
<td></td>
</tr>
<tr>
<td>12 22 16</td>
<td>DRAPERY TRACK AND ACCESSORIES</td>
<td></td>
</tr>
<tr>
<td>12 24 13</td>
<td>ROLLER SHADES</td>
<td></td>
</tr>
<tr>
<td>12 48 13</td>
<td>ENTRANCE FLOOR MATS AND FRAMES</td>
<td></td>
</tr>
<tr>
<td>12 66 13</td>
<td>TELESCOPING BLEACHERS</td>
<td></td>
</tr>
<tr>
<td>12 93 00</td>
<td>SITE FURNISHINGS</td>
<td></td>
</tr>
<tr>
<td>12 93 13</td>
<td>BICYCLE RACKS</td>
<td></td>
</tr>
<tr>
<td><strong>DIVISION 14</strong></td>
<td><strong>CONVEYING EQUIPMENT</strong></td>
<td></td>
</tr>
<tr>
<td>14 20 10</td>
<td>PASSENGER ELEVATORS</td>
<td></td>
</tr>
<tr>
<td><strong>DIVISION 21</strong></td>
<td><strong>FIRE SUPPRESSION (DELEGATED DESIGN)</strong></td>
<td></td>
</tr>
<tr>
<td>21 05 00</td>
<td>BASIC MATERIALS AND METHODS – FIRE PROTECTION</td>
<td></td>
</tr>
<tr>
<td>21 10 00</td>
<td>FIRE PROTECTION</td>
<td></td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

## DIVISION 22 PLUMBING
- 22 05 00  BASIC MATERIALS AND METHODS – PLUMBING
- 22 05 01  PLUMBING
- 22 07 00  PLUMBING INSULATION
- 22 11 23  PLUMBING EQUIPMENT
- 22 21 13  PLUMBING PIPING
- 22 21 23  PUMPS AND SPECIALTIES
- 22 40 00  PLUMBING FIXTURES

## DIVISION 23 HEATING, VENTILATING, AND AIR CONDITIONING
- 23 05 00  BASIC HVAC MATERIALS AND METHODS
- 23 05 33  HEAT TRACING
- 23 05 48  VIBRATION SEISMIC
- 23 05 93  TESTING, ADJUSTING, AND BALANCING
- 23 07 00  HVAC INSULATION
- 23 09 00  INSTRUMENTATION AND CONTROL
- 23 09 02  VARIABLE FREQUENCY DRIVES (VFD)
- 23 09 93  SEQUENCES OF OPERATION FOR HVAC CONTROLS
- 23 21 13  HVAC PIPING
- 23 21 23  PUMPS AND HYDRONIC SPECIALITES
- 23 31 13  AIR DISTRIBUTION
- 23 34 13  FANS AND VENTS
- 23 34 14  KITCHEN EXHAUST AND POLLUTION CONTROL
- 23 73 12  CUSTOM FACTORY AIR HANDLING UNITS
- 23 74 13  PACKAGED HVAC UNITS
- 23 81 25  MINI-SPLIT AIR CONDITIONING UNITS
- 23 81 58  VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS
- 23 82 19  SMALL CABINET FAN COIL UNITS
- 23 82 39  HEAT TRANSFER

## DIVISION 26 ELECTRICAL
- 26 05 00  COMMON WORK RESULTS
- 26 05 19  LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
- 26 05 26  GROUNDING AND BONDING
- 26 05 29  HANGERS AND SUPPORTS
- 26 05 33  RACEWAY AND BOXES
- 26 05 36  CABLE TRAYS FOR ELECTRICAL SYSTEMS
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 05 44</td>
<td>SLEEVES AND SLEEVE SEALS</td>
</tr>
<tr>
<td>26 05 48</td>
<td>VIBRATION AND SEISMIC CONTROLS</td>
</tr>
<tr>
<td>26 05 53</td>
<td>IDENTIFICATION</td>
</tr>
<tr>
<td>26 05 73</td>
<td>OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS</td>
</tr>
<tr>
<td>06 09 23</td>
<td>LIGHTING CONTROL DEVICES</td>
</tr>
<tr>
<td>06 09 36</td>
<td>MODULAR DIMMING CONTROLS</td>
</tr>
<tr>
<td>26 09 43</td>
<td>NETWORK LIGHTING CONTROLS</td>
</tr>
<tr>
<td>26 22 00</td>
<td>LOW-VOLTAGE TRANSFORMERS</td>
</tr>
<tr>
<td>26 24 13</td>
<td>SWITCHBOARDS</td>
</tr>
<tr>
<td>26 24 16</td>
<td>PANELBOARDS</td>
</tr>
<tr>
<td>26 27 13</td>
<td>ELECTRICITY METERING</td>
</tr>
<tr>
<td>26 27 26</td>
<td>WIRING DEVICES</td>
</tr>
<tr>
<td>26 28 13</td>
<td>FUSES</td>
</tr>
<tr>
<td>26 28 16</td>
<td>ENCLOSED SWITCHES AND CIRCUIT BREAKERS</td>
</tr>
<tr>
<td>26 29 23</td>
<td>VARIABLE FREQUENCY DRIVES</td>
</tr>
<tr>
<td>26 36 00</td>
<td>TRANSFER SWITCHES</td>
</tr>
<tr>
<td>26 51 00</td>
<td>INTERIOR LIGHTING</td>
</tr>
<tr>
<td>26 56 00</td>
<td>EXTERIOR LIGHTING</td>
</tr>
<tr>
<td><strong>DIVISION 27</strong></td>
<td><strong>COMMUNICATIONS</strong></td>
</tr>
<tr>
<td>27 05 28</td>
<td>COMMUNICATIONS PATHWAYS</td>
</tr>
<tr>
<td>27 11 00</td>
<td>COMMUNICATIONS EQUIPMENT ROOM FITTINGS</td>
</tr>
<tr>
<td>27 13 13</td>
<td>TELEPHONE BACKBONE CABLEING</td>
</tr>
<tr>
<td>27 13 23</td>
<td>OPTICAL FIBER BACKBONE CABLEING</td>
</tr>
<tr>
<td>27 13 33</td>
<td>CATEGORY 6A BACKBONE CABLEING</td>
</tr>
<tr>
<td>27 15 13</td>
<td>CATEGORY 5E HORIZONTAL CABLEING</td>
</tr>
<tr>
<td>27 41 16</td>
<td>INTEGRATED AUDIO-VIDEO SYSTEMS</td>
</tr>
<tr>
<td>27 70 80</td>
<td>CABLE TELEVISION CABLEING</td>
</tr>
<tr>
<td><strong>DIVISION 28</strong></td>
<td><strong>ELECTRONIC SAFETY AND SECURITY</strong></td>
</tr>
<tr>
<td>28 00 00</td>
<td>ELECTRONIC SAFETY AND SECURITY</td>
</tr>
<tr>
<td>28 10 00</td>
<td>ELECTRONIC ACCESS CONTROL &amp; INTRUSION DETECTION</td>
</tr>
<tr>
<td>28 20 00</td>
<td>ELECTRONIC SURVEILLANCE</td>
</tr>
<tr>
<td>28 31 11</td>
<td>DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM</td>
</tr>
<tr>
<td><strong>DIVISION 31</strong></td>
<td><strong>EARTHWORK</strong></td>
</tr>
<tr>
<td>31 10 00</td>
<td>SITE CLEARING ?</td>
</tr>
</tbody>
</table>

SERA Architects Inc. Packages 3 & 4 - 50% Construction Documents
TABLE OF CONTENTS

31 20 00  EARTH MOVING
31 22 00  GRADING
31 23 33  TRENCHING AND BACKFILL
31 25 00  EROSION CONTROL

DIVISION 32  EXTERIOR IMPROVEMENTS

32 12 00  FLEXIBLE PAVING
32 16 00  CONCRETE CURBS, GUTTERS, AND WALKS
32 80 00  IRRIGATION
32 90 00  PLANTING
32 94 47  FACTORY FABRICATED TRELLIS PANELS

DIVISION 33  UTILITIES

33 10 00  WATER UTILITIES
33 30 00  SANITARY SEWERAGE UTILITIES
33 39 13  SANITARY UTILITY SEWERAGE MANHOLES, FRAMES, AND COVERS
33 40 00  STORM DRAINAGE UTILITIES
33 49 13  STORM DRAINAGE MANHOLES, FRAMES, AND COVERS
33 51 00  NATURAL GAS DISTRIBUTION

END OF TABLE OF CONTENTS
PART 1 GENERAL

1.01 EXISTING CONDITIONS

   1. Original copy is available for inspection at Owner's offices during normal business hours.
   2. This report identifies properties of below grade conditions and offers recommendations for the design of foundations, prepared primarily for the use of Architect.
   3. The recommendations described shall not be construed as a requirement of this Contract, unless specifically referenced in the Contract Documents.
   4. This report, by its nature, cannot reveal all conditions that exist on the site. Should subsurface conditions be found to vary substantially from this report, changes in the design and construction of foundations will be made, with resulting credits or expenditures to the Contract Price accruing to Owner.

   1. Original copy is available for inspection at Owner's offices during normal business hours.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Summary of the Work.
B. Work by Owner.
C. Owner's occupancy.
D. Contractor's use of site and general limitations.
E. Definitions used throughout the Specification and Drawings.
F. Specification formats and conventions.

1.02 PROJECT
A. Project Name: Erb Memorial Union, Craft Center.
B. Owner's Name: University of Oregon.
C. The Project consists of the demolition, alteration and new construction of the Erb Memorial Union Craft Center.
D. The Project is registered with the US Green Building Council's LEED Green Building Rating System. The Owner's goal and the Contractor's responsibilities for LEED are summarized in Section 01 35 15 - LEED Requirements. Contractor's LEED responsibilities are part of the Work.

1.03 CONTRACT DESCRIPTION
A. Contract Type: A single prime contract based on a Stipulated Price as described in the Agreement.
B. Permit fee with the City of Eugene will be paid for by The University of Oregon.

1.04 DESCRIPTION OF ALTERATIONS WORK
A. Scope of demolition and removal work is shown on drawings and specified in Section 02 41 00.

1.05 WORK BY OWNER
A. Items noted FOIO (Furnished by Owner Installed by Owner) will be furnished and installed by Owner before Substantial Completion. Some items include:
   1. Furnishings.
   2. Small equipment.
   3. Artwork.
B. Owner will supply the following for installation by Contractor:
   1. Room numbering; See Appendix – Room Numbering Guide
   2. Specification of and providing of door hardware; OFCI.
   3. Exterior trash cans. Custom UO design and order, OFOI.
   4. Exterior benches; OFCI.
   5. Toilet dispenser accessories; OFCI.
   6. Exterior light poles, globes, lamps, and junction box; OFCI.
   7. Interior signage on small to medium projects only; OFOI.
   8. Exterior building marker signage; OFOI.
   9. Wall clocks; OFCI.
   10. Waste receptacles for all spaces; OFOI.
   11. Ash posts or smoking stations. OFOI; Custom UO fabrication.
   12. Walk off mats; OFOI.
C. Third party entities hired by the Owner may include, but are not limited to, the following:
   1. Cost estimator.
   2. Site survey.
   3. Certified arborist services.
   4. Special inspections and testing services (See Section 01 40 00).
   5. Water and air balancing and testing services.
6. Commissioning services.
7. Energy analyst.
8. Geotechnical consultant.
9. Hazardous materials testing and monitoring.
10. Asbestos removal.

1.06 OWNER OCCUPANCY
A. Owner intends to occupy the Project upon Substantial Completion.
B. Cooperate with Owner to minimize conflict and to facilitate Owner’s operations.
C. Schedule the Work to accommodate Owner occupancy.

1.07 CONTRACTOR USE OF SITE AND PREMISES
A. Construction Operations: Limited to areas noted on Drawings.
B. No Smoking Policy: Smoking is prohibited in Project Site.
C. Provide access to and from site as required by law and by Owner:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.
   3. Unless written approval is obtained, construction must not obstruct private or public streets, driveways, pedestrian walkways, ADA routes, fire lanes, egress of occupied buildings, etc.
   4. Coordinate construction detour routes for bikes, pedestrians, vehicles, etc. with FS Exterior Supervisor, PP, PM, and as needed DPS.
D. No disposal or recycling on university property outside construction area(s) unless approved by PM.
E. No burying of any demolition or construction materials on site.
F. No stockpiling of waste on-site beyond the period necessary for sorting and accumulation of practical quantities for transport off-site.
G. Description of Work times may be limited beyond requirements set by city codes.
H. In the event the Contractor encounters material that is believed to be hazardous, asbestos containing, coated with lead base paint, and/or oily debris the Contractor shall immediately stop work in the affected area and report the condition to the PM. At no time shall such material be disturbed, handled or disposed of by the Contractor. The Contractor will cooperate and work with the PM, EH&S, any Consultants, and abatement Contractors engaged by the Owner.
I. Protection of existing conditions:
   1. Provide necessary measures required to fully protect existing conditions.
   2. Restore permanent facilities used during construction to their specified and/or original condition.
J. When required, provide scaffolding erected by a certified erector following OSHA guidelines.
K. Reference Section 00 31 00 – Available Project Information, for information on known asbestos containing materials and locations to be provided protection to prevent disturbance.

1.08 DELEGATED DESIGN REQUIREMENTS
A. General requirements for Delegated Design components are specified in Section 01 33 16.
B. Specific design requirements are specified in Sections of Division 02 through 50.
C. Delegated design may sometimes also be referred to as "Design-Build." Both terms may be used interchangeably and have the same meaning.

1.09 DEFINITIONS
A. Basic Contract definitions are included in the Conditions of the Contract.

2. Basic contract definitions that are not defined in the General Conditions shall have the same meaning as defined in AIA Document A201 – 1997.

B. "AHJ": Authority Having Jurisdiction as defined in AIA Document A201.

C. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

D. "Delegated Design": Professional design service or certification specifically required of the Contractor in the Specifications. Such work is subject to provisions of AIA Document A201 § 3.12.10. The terms "Delegated Design," and "Design-Build," mean the same thing and are used interchangeably.

E. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."

F. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown, " "noted, " "scheduled, " and "specified" have the same meaning as "indicated."

G. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

H. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

I. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations, complete and ready for the intended use.

J. "Provide": Furnish and install, complete and ready for the intended use.

K. "Project Site": Space available for performing construction activities. The extent of Project site is shown in Drawings and may or may not be identical with the description of the land on which Project is to be built.

L. "Work": Project material "furnished" and "installed" complete and ready for the intended use.

1.10 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the CSI/CSC's MasterFormat 50-Division numbering system.

B. Sections in Division 01 govern the execution of the Work of all Sections in the Specifications and Drawings.

C. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
3. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Procedures for preparation and submittal of applications for progress payments.
B. Contract modification procedures.
C. Additional architectural service for extraordinary contract administration.
D. Procedures for preparation and submittal of application for final payment.

1.02 DEFINITIONS
A. Architectural Bulletin (AB): Architect's form issued by Architect indicating "Architect's Supplemental Instruction" or "Proposal Request" or "Construction Change Directive" or as a signature cover to Contractor initiated proposal.  
   1. AB Form is enclosed at end of Section.
C. Proposal Request (PR): A formal request from Architect to Contractor for change in Contract Sum and Time required to perform a proposed change in Work. Proposal Request is not a directive to perform the proposed change.
D. "Construction Change Directive" and "Change Order" have meanings defined in AIA Document A201.
E. Additional Contract Administration Services: Architectural service to enforce Contract Documents resulting from Contractor's failure to comply with requirements or Contractor's request for accelerated procedures.

1.03 SCHEDULE OF VALUES
A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
B. Forms filled out by hand will not be accepted.
C. Submit a printed schedule on AIA Form G703 - Application and Certificate for Payment Continuation Sheet. Contractor's standard form or electronic media printout will be considered.
D. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.
E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification Section. Identify site mobilization.
F. Include separately from each line item, a direct proportional amount of Contractor's overhead and profit.
G. Revise schedule to list approved Change Orders, with each Application For Payment.
H. See 1.4 Applications for Progress Payments for additional requirements.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS
A. Payment Period: Submit at intervals stipulated in the Agreement.
B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
C. Forms filled out by hand will not be accepted.
D. Present required information in typewritten form.
E. Form: AIA G702 Application and Certificate for Payment and AIA G703 - Continuation Sheet including continuation sheets when required.
F. Procedures for preparation and submittal of applications for progress payments in addition to those stated in the General Conditions and General Requirements also include:
   1. LEED project submittal summary is to be included with each payment application before application can be processed. Additionally, one half of one percent from each payment
application will be allocated and held until released upon approval of the final LEED submittal.

2. One half of one percent from each payment application will be allocated and held until released upon approval of the final Operation and Maintenance Manual submittal. The Contractor shall submit a draft Operation and Maintenance Manual to the Architect upon 75 percent project completion.

3. One half of one percent from each payment application will be allocated and held until released upon approval of the final Record Document submittal.

4. One half of one percent from each payment application will be allocated and held until released upon approval of the final Commissioning submittal.

5. The above items, where applicable, will be listed as separate line items on the Contractor's schedule of values.

G. Changes in the work shall be initiated using the SERA Architectural Bulletin (AB) Form.

H. Additional contract administration services is an additional architectural service and will be billed to the Owner who will then back-charge the Contractor.

I. Execute certification by notarized signature of authorized officer.

J. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored Products.

K. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of Work.

L. Submit three copies of each Application for Payment.

M. Include the following with the application:
   1. Construction progress schedule, revised and current as specified in Section 01 30 00.
   2. Current construction photographs specified in Section 01 30 00.
   3. LEED submittals applicable to work for which application is being made; see Section 01 35 16.
   4. Project Record Documents as specified in Section 01 78 00, for review by Owner which will be returned to the Contractor.
   5. Preliminary Closeout Documents when specified in Section 01 78 00.
   6. Affidavits attesting to off-site stored products.
   7. Contractor payment requests must be accompanied by all wage certificates for the billing period.

N. Materials stored off site and included in the schedule of values for monthly payment application are to be stored in a bonded and secure facility. Copies of bill of sale for materials and certificate of insurance for material with Owner named as an insured are to be included with the payment application.

O. When Architect requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.05 MODIFICATION PROCEDURES

A. For minor changes not involving an adjustment to the Contract Price or Contract Time, Architect will issue instructions directly to Contractor.

B. Architect will advise of minor changes in the Work not involving an adjustment to Contract Sum or Contract Time as authorized by the Conditions of the Contract by issuing supplemental instructions on Architectural Bulletin Form.

C. Construction Change Directive: Architect may issue an AB, signed by Owner, instructing Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
   2. Promptly execute the change.
D. Proposal Request: Architect may issue an AB which includes a detailed description of a proposed change with supplementary or revised Drawings and Specifications, a change in Contract Time for executing the change and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 15 days.

E. Contractor may propose a change by submitting a request for change to Architect, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation. Document any requested substitutions in accordance with Section 01 60 00. Contractor proposal will be processed in one of the following methods:
   1. Architect may reject Contractor proposal or may return it for modification.
   2. Architect may attach Contractor proposal to SERA AB, complete the AB appropriately, and distribute it for signatures.
   3. Architect may accept Contractor's form that has place for signatures, sign it and distribute to Owner for signature.

F. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
   1. For pre-determined unit prices and quantities, the amount shall be based on the fixed unit prices.

G. Substantiation and Computation of Costs: Provide complete itemized cost information with substantiating backup for each item for evaluation as follows:
   1. Quantities of products, labor, and equipment.
   2. Taxes, insurance, and bonds.
   3. Overhead and profit on products and labor only. Overhead and profit is limited as follows:
      a. Upper tier contractor: 5%
   5. Credit for deletions from Contract, similarly documented.
   6. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.

H. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

I. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

J. Promptly enter changes in Project Record Documents.

1.06 EXTRAORDINARY CONTRACT ADMINISTRATION SERVICE

A. Owner-Architect Agreement identifies certain additional services for which Architect may receive additional compensation. Some of these services may result out of actions or non-actions by Contractor; these include, but are not limited to:
   1. Design services for modification resulting from substitution proposed by Contractor.
   2. Review of submittals after the first re-submittal.
   3. Review or response to unnecessary or frivolous RFI.
   4. Second notification and review of non-compliant work.
   5. Design services to correct or incorporate non-compliant work.
   6. Design or engineering specified as Contractor's responsibility; for example, for design-build component or for performance-specified work.
   7. Performing administrative work specified as Contractor's responsibility when Contractor refuses to perform after notification.
   8. Performing administrative work specified as Contractor's responsibility when requested to expedite the Work.
9. Providing extra construction administration services after the specified date of Substantial Completion or the specified date of Final Completion when delay is not caused by Owner.
10. Re-inspection for Substantial Completion or Final Completion.

B. Architect will issue Notice for Extraordinary Contract Administration Services to Owner and a copy to Contractor. Thereafter, Architect will record time and expense for each occurrence, or in the case of recurring occurrences, each type of occurrence.
   1. Architect will, at their discretion, invoice Owner monthly for additional services.
   2. Architect’s fee schedule for additional services is included in Owner-Architect Agreement, and is available to Contractor upon request.

C. Owner reserves the right to charge the cost of Architect’s extraordinary contract administration service plus 10% administration cost to Contractor in an AB.

1.07 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following have been accomplished:
   1. All closeout procedures specified in Section 01 70 00. Prior to any final payment(s) all required as-built and O&M documentation as listed in Section 01 70 00 must be received by Owner.
   2. Affidavit that payrolls and bills have been satisfied.
   3. Consent of Surety to make Final Payment.
   4. Certificate evidencing that Builder’s Risk Insurance required after Substantial Completion will remain in force, and a written statement that Contractor knows of no reason that insurance will not be renewed for the required period until Final Payment.
   5. Prior to any final payment(s) all keys checked out to Contractor(s) and/or Consultant(s) must be returned to DPS and a receipt of return provided to PM by DPS.

END OF SECTION
Subject

The following instruction is hereby issued:

ARCHITECT’S SUPPLEMENTAL INSTRUCTION (complete PART A only)

The Work shall be carried out in accordance with the following supplemental instructions issued in accordance with the Contract Documents without change in Contract Sum or Contract Time. Proceeding with the Work in accordance with these instructions indicates the Contractors acknowledgement that there will be no change in the Contract Sum or Contract Time.

PROPOSAL REQUEST (complete PART A only)

Please submit an itemized quotation for changes to the Contract Sum and/or Contract Time incidental to the proposed modifications of the Contract Documents described below. DO NOT PROCEED WITH WORK UNTIL RECEIVING FURTHER WRITTEN INSTRUCTION This is not a change order, a construction change directive or a direction to proceed with the work described herein.

CONSTRUCTION CHANGE DIRECTIVE (complete PARTS A & B)

You are hereby directed to make the following change(s) in this Contract. Track the costs of changes to the Contract as described in proposed adjustments (Part B) below.

PART A: DESCRIPTION OF WORK

X.1 (DISPOSITION) (Description – describe work scope in this space – text to be Title Case and not bold. Column to left, i.e. “disposition” to denote type of change using on the following works (or iterations), “ADD”, “DELETE”, “CLARIFY”, or “CHANGE”. Disposition text to be ALL CAPS and bold.)

ATTACHMENTS

Issued by: SERA Architects, Inc.

PART B: PROPOSED ADJUSTMENTS

1. The proposed basis of adjustment to the Contract Sum or Guaranteed Maximum Price is:

   Unit Price of $   per
   Lump Sum (increase) (decrease) of $  
   As provided in Subparagraph 7.3.3 of AIA Document A201 1997 Edition
   As follows:

2. The Contract Time is proposed to:

   Remain unchanged
   Be adjusted with an (increase) (decrease) of   days
PART 1 - GENERAL

1.01 SUMMARY
A. Section includes procedure for coordinating and submitting Request for Interpretation.

1.02 DEFINITIONS
A. RFI: Request from Contractor to Architect seeking interpretation or clarification of the Contract Documents.

1.03 RFI PROCEDURE
A. Review Contract Documents and Project Site in a thorough and timely manner so Architect will have sufficient time to respond to RFI prior to execution of subject construction.
   1. Claim for additional Time or Cost when RFI is answered within time limit specified in this Section will be rejected.
B. Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.
   1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
C. When possible, request interpretation at next Progress Meeting. Record Architect's response in meeting minutes.
   1. When response is not given during meeting, submit RFI in approved format.

1.04 SUBMITTALS
A. RFI Form: Electronic form furnished by Architect, numbered and signed by Contractor.
   1. Number each page of attachments with RFI number in lower right corner.
   2. Attachments shall be electronic files in Adobe Acrobat PDF format.
   3. Alternative RFI Form: Subject to Architect's approval, Contractor software-generated form modified to match Architect's form. Numbering and attachments as specified in this Section.
B. RFI Content: Include detailed, legible description of item needing interpretation and the following:
   1. Project name and number.
   2. Date.
   3. Name of Contractor.
   5. RFI number, numbered sequentially. Add revision numbers as decimal and digit.
   6. RFI subject title, less than five words
   7. Initiator of question
   8. Specification Section number and title and related paragraphs, as appropriate.
   9. Drawing number and detail references, as appropriate.
   10. Field dimensions and conditions, as appropriate.
   11. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state anticipated impact in the RFI.
   12. Contractor's signature.
   13. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
      a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
   14. Single discipline per RFI: Architectural, Civil, Structural, Mechanical or Electrical
   15. Space for reply on same page, if possible.
C. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use CSI Log Form 13.2B or approved form. Include the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect.
   4. RFI number including RFIs that were dropped and not submitted.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's response was received.
   8. Identification of related Minor Change in the Work, Instrument of Change, Construction Change Directive, or Proposal Request, as appropriate.

1.05 ARCHITECT'S ACTION

A. Architect will review each RFI, determine action required, and return it. Allow 14 days for Architect's response for each RFI; and additional 7 days for consultant review. RFIs received after 1:00 p.m. will be considered as received the following working day.
   1. Failure to allow specified response time will not be cause for an extension of Contract Time or additional cost.
   2. Architect's goal will be to return RFI as quickly as possible. However, quick response is not guaranteed.
   3. The following RFIs are defined as frivolous and will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for information already indicated in the Contract Documents.
      d. Requests for information derived from activities assigned to Contractor in the Contract Documents.
      e. Requests for approval of adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or RFIs with numerous errors.
      h. Questions relating to construction means, methods, techniques, sequences, procedures or safety precautions. (These are Contractor's responsibility exclusively.)
      i. Questions relating to construction schedule, coordination between trades, or division of work among subcontractors. (These are also Contractor's responsibility exclusively.)
   4. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
   5. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Contract Modification Procedures.
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
      b. Do not proceed with this work until Change Order is executed.

B. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within 5 days if Contractor disagrees with response.

C. Frivolous RFI: Architect may claim compensation for cost of Architect's time and materials as a result of unnecessary or frivolous RFIs. Compensation will be assessed to Contractor in accordance with Section 01 20 00 - Price and Payment Procedures.

1.06 QUALITY ASSURANCE

A. Contractor shall strive to keep the number of RFIs to a minimum.
   1. Prior to submitting RFI, carefully study Contract Documents to assure that requested information is not already available. RFIs that request information available in the Contract Documents will be considered frivolous.
B. RFI is not a substitute for Shop Drawing. When multiple RFIs are submitted for related work, Architect may require a Shop Drawing.

C. RFI submitted by Fax is not acceptable.

END OF SECTION
Request for Interpretation

Project Name:
Project Number:
Request for Interpretation No.:
Owner:
Date Issued:
Attention:
Time:
Owner Contract No. (if any):
Contractor:

The Work shall be carried out in accordance with the following supplemental instructions issued in accordance with the Contract Documents without change in Contract Sum or Contract Time. Proceeding with the Work in accordance with these instructions indicates your acknowledgement that there will be no change in the Contract Sum or Contract Time.

Description:
Specification Section: __________________________ Paragraph: ________ Article: __________________________
Drawing Title: __________________________ Sheet #: ________ Reference: __________________________
Request: __________________________

Requested By: __________________________ Initiating Sub. (if app.): __________________________
Title: __________________________ Request Reply By: __________________________

Architect/Consultant Response:
Accepted: ☐ Accepted as Noted: ☐ Not Accepted: ☐
Response: __________________________

BY: __________________________ Date: __________________________

Attachments:
☐ Owner ☐ Consultant ☐ Contractor ☐ Other
☐ Architect ☐ Consultant ☐ Field ☐ Other
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project coordination.
B. Communication with Architect.
C. Coordination Drawings.
D. Pre-construction meeting.
E. Progress meetings.
F. Pre-installation meetings.

1.02 SUBMITTAL PROCEDURES

A. Specified in Section 01 33 00 - Submittal Procedures

1.03 SUBMITTALS

A. Construction Submittal Requirements:
B. PM shall receive a minimum of one stamped original of all submittals at the time of Consultant approval.
C. PM will provide the A/E and GC with a list of submittal items that require concurrent FS Maintenance & PM review and approval prior to official submittal acceptance. This list consists of, but is not limited to the following items:
   1. Variable Frequency Drives, VFD
   2. AHU and motor-mounts
   3. Transformers
   4. Building controls
   5. Soils
   6. Light Fixtures
   7. Backflow devices
   8. Fire Alarm systems
   9. Fire sprinkler components
D. Pre-Construction Meeting Submittals: Bonds, insurance, schedule of values, project personnel directory, subcontractor and supplier list, and other lists; specified in other Sections.
E. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
   1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.
F. Minutes of meetings required in this Section.
G. Coordinated Ceiling Drawings: Submit within 60 days of Notice to Proceed. Submit 1 set of color plots or color copies on white bond paper. Transmit CADD files.
   1. Architect will review, stamp and return one copy with comments within 14 days after receipt. Procedure requirements for Shop Drawings in Section 01 33 00 apply.
   2. Architect's review is for compliance with design intent and does not relieve Contractor of coordination and performance requirements.
   3. Copy reviewed drawings and distribute to appropriate entities.

1.04 PROJECT COORDINATION

A. Coordinate construction operations specified in different Sections to ensure efficient and orderly installation of each part of the Work. Coordinate portions of work that depend on each other for proper installation, connection, and operation.
B. In the event of an inconsistency in the Drawings or between the Drawings and the Specifications, unless otherwise ordered in writing by the Architect, the Contractor shall provide the greater quantity and/or better quality of work.

C. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
   1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
      a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
      b. Indicate required installation sequences.
      c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
   2. Sheet Size: At least 8-1/2 by 11 inches but no larger than Project Drawings.
   3. Media: CADD electronic "dwg" files unless other media is approved by Architect.

1.05 DIGITAL COMMUNICATION
A. Communication to Architect: High speed internet based digital, except Submittals specified in Section 01 33 00.
   1. Telephone communication is acceptable for initial or simple issues.
   2. Follow up telephone communication in writing.
B. Construction Office Equipment:
   1. High speed internet connection equipment and service.
      a. Email Attachment Capacity: Not less than 10 megabytes.
   2. Computer with internet connection and project management software:
      c. Project scheduling software.
   3. Scanner, not less than 150 dpi.
   4. Copy machine not less than 400 dpi with capability for 11 x17 and color.
   5. Telephone with conference call capability
   6. Digital camera, 3.5 megapixel minimum.
C. Correspondence:
   1. correspondence by FAX is not acceptable unless specifically approved.
   2. Any information that is disseminated shall retain the original scale and aspect from the original as published by Architect.

1.06 COORDINATED CEILING DRAWINGS
A. Content and View: Two views, concealed conditions and visually exposed conditions, shown as reflected plans. Indicate actual size of components at scale sufficient to show no interference and adequate space for installation and maintenance of each component.
   1. Concealed Conditions View: Including, but not limited to: mechanical systems (plumbing, ductwork, HVAC Equipment, piping, controls, fire protection systems, etc.); electrical systems (wiring, raceway, conduit, cable trays, controls, fire and life safety systems, lighting, alarm devices, etc.); structural elements (beams, girders, etc); acoustical systems, ceiling equipment supports.
   2. Exposed Conditions View: Including, but not limited to: mechanical; electrical; structural elements as noted above; acoustical systems; lights – pendants, surface and recessed; exit signage; directional signage; conduit; grilles; diffusers; damper actuators; sprinkler systems, etc.
heads/type, speaker locations, access panels with sizes indicated, smoke detectors and alarm devices, and any other item or element that will be seen when looking at the ceiling.

B. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

C. Congested Areas: Provide more detailed plan and either vertical sections or 3-dimensional CADD model.

D. Media: CADD plans, sections, and models for color plotting; ".dwg" file format.

E. Show the following in different colors for each system: structure, HVAC, plumbing, piping, electrical, fire protection, other work.

F. Distribute Coordinated Ceiling Drawings among affected entities for review. Resolve conflicts and incorporate corrections into drawings prior to submitting to Architect.

1. Work that is not included in Coordinated Ceiling Drawings shall be coordinated and installed without conflicts or defects, and without change in Time or Cost.

1.07 PRECONSTRUCTION MEETING

A. Owner/Architect will schedule meeting after Notice to proceed.

B. Meeting location shall be either on site at FS or conducted by the Lead Consultant with PM.

C. Attendance Required: Owner, Owner’s project manager, Architect and Contractor.

D. Agenda items at a minimum and/or applicable include the following; List is subject to addition as needed:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
4. Submission of complete list of Subcontractors, with contact information, list of products, schedule of values, submittal schedule, and construction progress schedule with any critical path work sequencing and long lead time materials.
6. Procedures and processing of field decisions, submittals, substitutions, RFIs, requests for applications for payments, proposal request, Change Orders, and Contract closeout procedures.
7. Construction site access: pick-up, delivery, and parking; temporary facilities and controls, security, safety, and restrictions.
8. Scheduling activities of Testing Agent.
10. Anticipated building service or system interruptions, and impact to building operations/occupants.
11. Owner occupancy, schedule, and activities requiring accommodation and/or coordination.
12. Use of site, campus premises, and existing buildings.
13. Office, work, and storage areas.
14. All shut-off locations.
15. Define plan to reduce impact to building users regarding application of finishes, paints, adhesives, etc.
16. Utility mete removals or connections.
17. Facilities EH&S items include but are not limited to the following:
   a. List of emergency contacts, and contact information.
   b. Process for accessing emergency assistance.
   c. Process for spills and clean-up.
   d. EH&S expectations regarding maintaining safe conditions for UO employees, students, visitors, construction workers, etc. including odors, egress, avoidance of fire alarms, etc.
   e. If applicable, EH&S expectations regarding compliance with erosion control permits.
E. Contractor shall record minutes and distribute copies within four (4) days after meeting to participants, with one original copy to Architect, Owner and those affected by decisions made.

1.08 CONSTRUCTION PROGRESS MEETING REQUIREMENTS

A. Schedule and administer meetings throughout progress of the Work at maximum weekly intervals.
   1. Architect may elect to attend by telephone conference call.

B. Attendance Required: Job superintendent, major subcontractors and suppliers, Owner, or Owner’s representative, Architect/Engineer, as appropriate to agenda topics for each meeting. Architect shall attend in person or via conference call at Architect’s discretion.

C. Meeting location shall be on site and conducted by the GC or CM.

D. Meeting minutes shall be by the GC or CM and distributed to attendees and to individuals requesting courtesy copies.
   1. Courtesy copies shall be provided to N&TS.

E. Agenda items at a minimum and/or applicable include the following; List is subject to addition as needed:
   1. Review minutes of previous meetings.
   2. Review of Work progress overall construction schedule progress and status.
   3. Field observations, problems, and decisions.
   4. Identification of problems impeding planned progress.
   5. Review of submittals schedule and status, RFI’s and status, and proposal requests/change orders and status.
   6. Review of off-site fabrication and delivery schedules.
   7. Maintenance of construction progress schedule with 3 week detailed schedule of coming weeks’ activities and needed shutdowns.
   8. Corrective measures to regain projected schedules.
   9. Planned progress during succeeding work period with 3 week detailed schedule of coming weeks’ activities and needed shutdowns.
  10. Coordination of projected progress.
  11. Maintenance of quality and work standards.
  12. Effect of proposed changes on progress schedule and coordination.
  13. Owner schedule and activities requiring accommodation and/or coordination.
  14. Site access & utilization and any changes due to construction or delivery activities.
  15. Work hours and notification of evening or weekend events needing notification to campus.
  17. Pending changes.
  18. Payment request status.
  19. Other business relating to Work.

F. Contractor shall record minutes and distribute copies within four (4) days after meeting to participants, with one (1) original copy to Architect, Owner, and those affected by decisions made.

1.09 PRE-INSTALLATION MEETING

A. When required in individual specification sections, convene pre-installation meeting at Project site prior to commencing work of specific section.

B. Work undertaken or completed without convening a pre-installation meeting shall be subject to removal, inspection, testing, observation, etc at the Architect’s discretion without additional compensation to Contractor in time or money. Work required as a result of removal, inspection, testing, observation, etc., even though determined to be satisfactory, shall be provided without additional compensation to the contractor in time or money.

C. Require attendance of parties directly affecting, or affected by, Work of specific section including the Architect, Owner, Design Engineer, manufacturer (representative and technical support) and key personnel of the installation team.
D. Notify Architect seven (7) days in advance of meeting date.

E. Prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

F. Record minutes and distribute copies within four (4) days after meeting to participants, with one original copy to Architect, Owner, and those affected by decisions made.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Preliminary schedule.
   B. Construction progress schedule, with network analysis diagrams and reports.
   C. Short interval schedule.

1.02 REFERENCES
   A. AGC (CPSM) - Construction Planning and Scheduling Manual; Associated General Contractors of America; 2004.

1.03 SUBMITTALS
   A. Within 10 days after date of Agreement, submit Preliminary Schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.
      1. List Owner and other scheduled or projected building user activities and milestones coordinated within the construction activities schedule.
      2. List Owner Furnished Contractor Installed (OFCI) and Owner Furnished Owner Installed (OFOI) items, delivery dates, and completion dates.
      3. Required shutdowns must be requested by the Contractor to PM a minimum of two (2) weeks in advance.
      4. Notify PM for distribution of advanced notice to campus a minimum of forty eight (48) hours prior to start of disruptive work, including but not limited to vibration, noise, or odors that may occur within occupied buildings or neighboring buildings.
      5. List commissioning activities and milestones.
   B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
   C. Within 20 days after review of preliminary schedule, submit draft of proposed Baseline Schedule for review.
      1. Include written certification that major contractors have reviewed and accepted proposed schedule.
      2. Include narrative report that identifies critical, near-critical and major activities in sufficient detail that explains their significance.
   D. Within 10 days after joint review, submit Baseline Schedule.
   E. Submit updated schedule with each Application for Payment.
   F. Short Interval Schedule: Submit copies to attendees at each Progress Meeting.

1.04 QUALITY ASSURANCE
   A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with 5 years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

1.05 SCHEDULE FORMAT
   A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.
   B. Diagram Sheet Size (overall schedule): Maximum 22 x 17 inches or width required.
   D. Scale and Spacing: To allow for notations and revisions.
PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE
   A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 BASELINE SCHEDULE
   A. Baseline (Construction Progress) Schedule is a continuation of the Preliminary Schedule that shows the entire, complete construction activity. Actual progress of the Work will be measured against the Baseline Schedule.
   B. Revisions to the accepted Baseline Schedule are subject to review and approval.

3.03 CONTENT
   A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.
      1. Include Pre-Installation Meetings.
   B. Identify each item by specification section number.
   C. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.
   D. Provide separate schedule of submittal dates for shop drawings, product data, and samples, owner-furnished products, Products identified under Allowances, and dates reviewed submittals will be required from Architect. Indicate decision dates for selection of finishes.
      1. Refer to Section 01 33 00 for more requirements.
   E. Indicate delivery dates for owner-furnished products.
   F. Provide legend for symbols and abbreviations used.

3.04 NETWORK ANALYSIS
   A. Prepare network analysis diagrams and supporting mathematical analyses using the Critical Path Method.
   B. Illustrate order and interdependence of activities and sequence of work; how start of a given activity depends on completion of preceding activities, and how completion of the activity may restrain start of subsequent activities.
   C. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
      1. Preceding and following event numbers.
      2. Activity description.
      3. Estimated duration of activity, in maximum 15 day intervals.
      4. Earliest start date.
      5. Earliest finish date.
      6. Actual start date.
      7. Actual finish date.
      8. Latest start date.
      9. Latest finish date.
     10. Total and free float; float time shall accrue to Owner and to Owner's benefit.
     11. Monetary value of activity, keyed to Schedule of Values.
     12. Percentage of activity completed.
   D. Analysis Program: Capable of accepting revised completion dates, and recomputation of all dates and float.
   E. Required Reports: List activities in sorts or groups:
      1. By preceding work item or event number from lowest to highest.
      2. By amount of float, then in order of early start.
      3. Listing of activities on the critical path.
3.05 REVIEW AND EVALUATION OF SCHEDULE
   A. Participate in joint review and evaluation of schedule with Architect at each submittal.
   B. Evaluate project status to determine work behind schedule and work ahead of schedule.
   C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.06 UPDATING SCHEDULE
   A. Maintain schedules to record actual start and finish dates of completed activities.
   B. Indicate progress of each activity to date of revision, with projected completion date of each activity.
   C. Annotate diagrams to graphically depict current status of Work.
   D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
   E. Indicate changes required to maintain Date of Substantial Completion.
   F. Submit reports required to support recommended changes.
   G. Provide narrative report to define problem areas, anticipated delays, and impact on the schedule. Report corrective action taken or proposed and its effect including the effects of changes on schedules of separate contractors.

3.07 RECOVERY SCHEDULE
   A. Prepare and submit Recovery Schedule and Narrative Report that demonstrates how lost time will be recovered when one of the following occurs:
      1. Project falls behind schedule more than 14 days.
      2. Project falls behind schedule more than 10% of remaining duration to Substantial Completion.
   B. Submit Recovery Schedule within 7 days of falling behind schedule.
   C. Recovery Schedule is subject to review and approval.

3.08 DISTRIBUTION OF SCHEDULE
   A. Distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Architect, Owner, and other concerned parties.
   B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

3.09 SHORT INTERVAL SCHEDULE
   A. Description: Three week schedule of current and near-future construction activity.
      1. Duration: 3 weeks
      2. Time Increment: Day
      3. Bar chart with separate bar for each trade that is active at Site, sequentially organized, beginning with continuing activities.
      4. Indicate crew size for each activity.
      5. If activity differs from Baseline Schedule, compare Baseline to proposed activity as adjacent bars.
      1. Hand drafted or computer generated schedule at Contractor's option.
   C. Update schedule weekly.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittal control report and submittal procedure.
B. Proposed products list.
C. Product data.
D. Sustainable building data.
E. Shop drawings.
F. Samples.
G. Design data.
H. Test reports.
I. Certificates.
J. Manufacturer's instructions.
K. Manufacturer's field reports.
L. Construction photographs.

1.02 SUBMITTAL CONTROL REPORT

A. Prepare and maintain a separate material delivery log to monitor submittals required by the contract documents. Show:
   1. Work item number corresponding to the specification section and construction schedule.
   2. Contractor, subcontractor, sub-subcontractor or supplier responsible for each work item.
   3. Narrative description of the work item.
   4. Number of days required for preparation of the submittal.
   5. Date submittal due.
   6. Number of days allowed for approval.
   7. Date approval due.
   8. Number of days required to fabricate and deliver item to the Contractor.
   9. Date of delivery.
   10. Date item required to be installed, corresponding to the construction schedule.

B. Distribution:
   1. Distribution copies of reviewed schedule to: Architect, Owner’s Representative.
   2. Instruct recipients to report any inability to comply and provide detailed explanation with suggested remedies.

1.03 SUBMITTAL PROCEDURE

A. Construction Submittal Requirements:
   1. PM shall receive a minimum of one stamped original of all submittals at the time of Consultant approval.
   2. PM will provide the A/E and GC with a list of submittal items that require concurrent FS Maintenance & PM review and approval prior to official submittal acceptance. This list consists of, but is not limited to the following items:
      a. Variable Frequency Drives, VFD
      b. AHU and motor-mounts
      c. Transformers
      d. Building controls
      e. Soils
      f. Light Fixtures
      g. Backflow devices
      h. Fire Alarm systems
      i. Fire sprinkler components

B. Organize and submit complete information into separate submittals for each Specification Section listed in Table of Contents, except as follows:
SUBMITTAL PROCEDURES

1. Consolidated Division submittal for Sections in the following Divisions:
   a. Division 21, 22, and 23.
   b. Division 26, 27 and 28.
   c. Division 31, 32, and 33, except 1 separate consolidated submittal for Landscaping is acceptable.

2. Doors, door frames and door hardware: 1 consolidated submittal.

3. Exterior curtainwall, storefront and entrance systems: 1 consolidated submittal.

4. Exceptions must be approved by Architect.

C. Number submittals sequentially, followed by specification Section number.
   1. Revisions: Add "R-1" to submittal number; example "034- 08 51 13 R-1".

D. Transmittal or Cover Sheet: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will discard submittals received from sources other than Contractor.
   1. Transmittal Form: Use CSI Form 12.1A.
   2. Incomplete transmittal form will be returned.

E. Contractor's Review: Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
   1. Review submittals prior to submission and provide stamp of approval signed or initialed by Contractor.
      a. Contractor’s review indicates that Contractor has thoroughly reviewed the submittal and certifies that it is complete, correct, in compliance with the Contract Documents, and suitable for the Project.
      b. Review represents that field measurements and field conditions have been considered and that the work submitted will perform as intended.
      c. Review of Shop Drawing represents that required coordination with other work has been performed and is indicated in Shop Drawing.
   2. Architect will not review submittals that do not include Contractor's signed review stamp, do not include required field conditions, or are not accurate.
   3. Include written description and graphic demarcation of deviations from requirements of Contract Documents.
   4. All work done prior to approval of submittals shall be at the Contractor’s risk.

F. Clearly indicate all options, colors, accessories, data, etc, provided for this Project.

G. Identify variations from Contract Documents. Identify product limitations which may be detrimental to successful performance of completed Work.

H. Allow space on submittals for Contractor and Architect review stamps.

I. Schedule submittals to expedite Project. Deliver submittals to Architect at SERA Architects Inc. Coordinate submission of related items.
   1. Deliver one additional copy each to Owner

J. For each submittal, allow 14 days excluding delivery time from and to Contractor.
   1. Allow additional 7 days for any one of the following submittals:
      a. Major building components or consolidated submittals.
      b. Review by Architect's consultant.
      c. Review by Commissioning Agent.

K. When revised for resubmission, identify changes made since previous submission.

L. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

1.04 PRODUCT DATA

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. Provide product data whether specified or not specified in Section.
2. If information that must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
3. Mark each copy of each submittal to show which products and options are applicable.

B. Include the following information, as applicable:
   1. Manufacturer’s written recommendations.
   2. Manufacturer’s product specifications.
   3. Manufacturer’s installation instructions.
   5. Manufacturer’s catalog cuts.
   6. Wiring diagrams showing factory-installed wiring.
   7. Printed performance curves.
   8. Operational range diagrams.
   10. Standard product operation and maintenance manuals.
   11. Compliance with specified referenced standards.
   12. Testing by recognized testing agency.
   13. Application of testing agency labels and seals.
   14. Notation of coordination requirements.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers’ standard data to provide information specific to this Project.

D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. Submit one electronic copy in PDF format.
F. Architect will return a reviewed electronic copy in PDF format.

1.05 SUSTAINABLE BUILDING DATA

A. Submit information applicable to Sustainable Building Requirements and Environmental Responsibility.
   1. Recycled content as applicable: Percent post consumer and percent post industrial, on Manufacturer’s letterhead or published data certified by SCS.
   2. Rapidly renewable materials as applicable: List percent of materials whose source is replaced or renewed within a 10 year period.
   3. Local materials as applicable: List material amount, cost, source of manufacture and distance to site in miles, on Manufacturer’s letterhead.
   4. Locally harvested or extracted as applicable: List material amount, cost, source and distance to site in miles, on Manufacturer’s letterhead.
   5. Levels of Volatile Organic Compounds (VOC).

1.06 SHOP DRAWINGS

A. Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on standard printed data or reproductions of the Contract Documents, unless submittal of Architect’s CAD Drawings is permitted.
   1. Provide Shop Drawings for work indicated in Sections and when needed to execute the Work.

B. Electronic copy of Architect’s CADD drawings (floor plans, site plan and ceiling plans, only) will not be provided.

C. Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
   1. Dimensions.
   2. Three dimensional axonometric views of flashings, pans and sheet metal details.
   3. Identification of products.
   4. Fabrication and installation drawings.
SUBMITTAL PROCEDURES

5. Roughing-in and setting diagrams.
6. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
7. Manufacturing instructions.
8. Templates and patterns.
10. Design calculations.
11. Compliance with specified standards.
12. Notation of coordination requirements.
13. Notation of dimensions established by field measurement.
14. Relationship to adjoining construction clearly indicated.
15. Seal and signature of professional engineer if specified.

D. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. Submit copies or transparencies as follows:
1. 8.5 by 11 inch or 11 by 17 inch size: Submit 4 copies on bond paper.
2. Larger than 11 by 17 inches: Submit 4 copies on bond paper.
3. Submit 1 additional copy for Architect’s consultant’s review.

1.07 SAMPLES

A. Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

B. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

C. Identification: Attach label on unexposed side of Samples that includes the following:
1. Generic description of Sample.
2. Product name and name of manufacturer.
3. Sample source.
4. Number and title of appropriate Specification Section.

D. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
1. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
2. Samples not incorporated into the Work, or otherwise designated as Owner’s property, are the property of Contractor.

E. Samples for Initial Selection: Submit 2 manufacturer’s color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

F. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
1. Submit three sets of Samples. Architect will retain one Sample set; remainder will be returned.
2. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
3. If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
G. Finishes, products and/or materials noted as custom, hand worked, etc shall be submitted to Architect for review and approval prior to fabrication/installation. Allow for minor revisions to sample in terms of finish, fabrication, installation and/or sequencing.

H. Field Samples: Large size samples and assembled samples that shall be submitted at the Project Site are specified in individual Sections.

1.08 DESIGN DATA
A. Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

B. Submit for Architect's information.
   1. Architect's review is limited to assessing conformance with design concept expressed in Contract Documents.

C. Refer to Section 01 33 16 - Delegated Design Procedures.

1.09 TEST REPORTS
A. Submit for Architect's knowledge.

B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.10 CERTIFICATES
A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Architect, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect.

1.11 QUALIFICATION DATA
A. When specified in individual specification sections or requested by Architect, submit qualifications for manufacturer, installer, or subcontractor.

B. Data may include previous experience, list of previous similar projects, references, proof of training, and approval by manufacturer or warrantor.

1.12 SAMPLE WARRANTY
A. When warranty is specified in a Section, submit sample of specified warranty with initial product submittal.

B. Final warranty submittal is specified in Section 01 78 00 - Closeout Submittals.

1.13 MANUFACTURER'S INSTRUCTIONS
A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Architect for delivery to Owner in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.14 MANUFACTURER'S FIELD REPORTS
A. Submit reports for Architect's benefit as contract administrator or for Owner.

B. Submit report in duplicate within 30 days of observation to Architect for information.

C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.
1.15 CONSTRUCTION PHOTOGRAPHS

A. Photographic Documentation Requirements by Contractor:
   1. This requirement may be waived at Owner discretion.
   2. Monthly, an 8”x10” printed photograph. On the front of the photograph identify the project name, location where photograph was taken, and month/date/year.
   3. At project start before demolition, a photo record of the project site, surrounding and adjacent structures and conditions.
   4. At final completion, final color photo documentation; date stamped on the back of the photo.
   5. With closeout documentation submittal a complete digital set of all construction photographs shall be included.

B. Provide photographs of site and construction throughout progress of Work.
C. Each month submit photographs with Application for Payment.
D. Photographs: Digital camera, 3.5 mega pixel minimum.
E. Take one (1) site photograph from same direction indicating relative progress of the Work.
F. Deliver digital copies to Owner on approved media (CD, DVD) with project record documents. Catalog and index files in chronological sequence; include word processor table of contents.

END OF SECTION
THIS AGREEMENT is entered into effective [insert date] by and between [insert party’s company name] (“Recipient”) and SERA Architects, Inc. (“SERA”) with respect to the [insert project name] (“Project”) located at [insert location].

The Recipient has requested that SERA provide to the Recipient certain drawings, specifications or other documents for the Project in electronic form (“Electronic Form Documents”). SERA agrees to do so, subject to the terms and conditions of this Agreement.

The Recipient recognizes that the Electronic Form Documents may be revised by others without the knowledge or consent of SERA and, when plotted, may result in variances or corrupt other files of the user.

The Recipient agrees not to use the Electronic Form Documents for any purpose or project other than the Project.

The Recipient acknowledges that the Electronic Form Documents are the property of SERA or its consultants and are subject to the copyrights and other reserved rights of those parties. The Electronic Form Documents may be write-protected by SERA such that no data can be manipulated by the Recipient or third parties. SERA may provide to the Recipient only a working copy of Electronic Form Documents which have all indices of SERA, its consultants, and their respective ownership, professional names, and involvement in the Project removed from the electronic display.

Any use of or changes to the Electronic Form Documents shall be at the sole risk of the user, and without liability, risk or legal exposure to SERA or its consultants. The Recipient and any other person or entity using the Electronic Form Documents agrees to release and, to the fullest extent permitted by law, indemnify, hold harmless and defend SERA, its consultants, and their respective partners, shareholders, agents and employees from and against any and all claims, demands, losses, expenses, damages, penalties and liabilities of any kind, including without limitation attorneys’ and expert witnesses’ fees, arising out of or relating in any way to any such use of or changes to the Electronic Form Documents.

Under no circumstances shall SERA’s transfer of the Electronic Form Documents to the Recipient be deemed a sale by SERA or its consultants. SERA and its consultants make no warranties, either expressed or implied, with respect to the Electronic Form Documents, including but not limited to warranties of merchantability or of fitness for any particular purpose.

The Recipient agrees, as a condition of providing the Electronic Form Documents to any contractor, design professional or other person or entity, to require such third party to agree in writing to the terms and conditions of this Agreement.

By electronically accessing the Electronic Form Documents, the Recipient accepts and is bound to the terms and conditions of this Agreement.

RECIPIENT: ________________________________
Company: ________________________________
Signature: ________________________________
Printed Name: ________________________________
Title: ________________________________
Date: ________________________________

SERA: ________________________________
SERA Architects, Inc.
Signature: ________________________________
Printed Name: ________________________________
Title: Principal
Date: ________________________________
PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:
   2. Permitting for Delegated Design portion of Work.
   3. Delegated Design submittals.

B. Coordinate and assume full responsibility for design, engineering, submittals, fabrication, transportation, and installation of this work.

C. Delegated Design portions include the following:
   1. Temporary shoring and supports for excavation, concrete, walls and other construction.
   2. Section 03 30 00 - Concrete mix design.
   3. Section 03 37 17 - Shotcrete; For shoring.
   4. Section 03 45 00 - Architectural Precast Concrete
   5. Section 05 50 00 - Metal Fabrications, for fabricated railings.
   6. Section 05 51 00 - Metal Stairs.
   7. Section 05 73 00 - Decorative Metal Railings
   8. Section 06 17 53 - Shop-Fabricated Wood Trusses; Plate-connected wood trusses.
   9. Section 07 42 13 - Metal Wall Panels; for furring system and panel attachment to structure.
   10. Section 07 62 00 - Sheet Metal Flashing and Trim;
   11. Section 07 81 00 - Applied Fireproofing.
   12. Section 07 84 00 - Firestopping
   13. Section 08 43 13 - Aluminum Storefronts.
   15. Section 08 46 13 - Aluminum Window Wall
   16. Section 08 53 13 - Vinyl Windows
   17. Section 08 63 00 - Metal Framed Skylights
   18. Section 08 80 00 - Glazing, for glass strength.
   19. Section 09 21 16 - Gypsum Board Assemblies; For non-structural metal-framed interior partitions, gypsum board ceiling suspension systems and perimeter requirements, and seismic bracing.
   20. Section 09 51 00 - Acoustical Ceilings, for ceiling suspension systems.
   21. Section 11 24 23 - Fall protection.
   22. Section 14 20 10 - Passenger Elevators, including supports for rails, sills and hoisting beams in Division 05. Elevators submittal through normal process, permit costs included for state inspection, and AHJ.
   23. Division 21 - Fire suppression system.
   24. Divisions 21, 22 and 23 - seismic restraint of systems.
   25. Divisions 26, 27 and 28 - seismic restraint of systems.
   27. Section 32 80 00 - Irrigation Systems.
   28. See structural notes for other delegated design items.

1.02 DEFINITIONS

A. Delegated Design: Professional design service or certification specifically required of the Contractor in the Specifications.

B. AHJ: Authorities Having Jurisdiction, defined in Section 01 10 00 and AIA Document A201.

1.03 PERFORMANCE REQUIREMENTS

A. Comply with Regulations.

B. Provide complete, operational systems that perform their intended use.

C. Engineer Delegated Design portions for gravity, lateral and seismic loads.
   1. Load criteria is indicated in Structural Drawings. If not indicated, request criteria.
2. Indicate reactions to structure.
3. Provide services of a qualified professional engineer licensed in the Project jurisdiction.

D. Calculate and complete energy forms required by AHJ.
E. Execute the design intent as indicated in Project Drawings and Specifications.
F. Obtain Permits and inspections and pay fees required by AHJ.

1.04 OWNER'S RESPONSIBILITIES
A. The Owner will not pay for progress delays, additional Work, additional products, restocking, or re-working required by Contractor's failure to coordinate Delegated Design work with other Project work.

1.05 SUBMITTALS
A. Preliminary Design: Submit to Architect drawings and product data that describe Contractor’s design prior to performing engineering calculations and Shop Drawings.
   1. Architect will evaluate proposed design and comment on conformance with intent of Contract Documents.
   2. Preliminary review is for aesthetic and general function concerns and will not constitute approval of engineering.
   3. Purpose of this submittal is to avoid engineering and detailing an unacceptable proposal.
B. Permit Review: Submit Delegated Design documents to AHJ for review and approval.
   1. When AHJ requires review by Architect or Architect’s consultant, allow 10 days for Architect’s review. Submit documents to Architect and pick-up documents when review is complete. Make corrections noted by Architect.
   2. Obtain permits prior to executing work component.
   3. Comply with AHJ requirements.
   4. Execute corrections to Delegated Design work required by AHJ at no cost to Owner and prior to Substantial Completion.
      a. Notify Architect of changes required by AHJ as soon as they are known.
   5. Include design criteria, design assumptions, structural calculations, fabrication and construction details, required clearances, and interface requirements.
      a. Delegated Design drawings are in addition to Shop Drawings.
   6. Affix Design Professional’s seal for State License on Submittals.
C. Engineer’s qualifications.
D. Product Data, Shop Drawings and Samples: Comply with requirements in Section 01 33 00 for each product of Delegated Design portion of work. Product submittals are in addition to submittals for permit and design data.

1.06 QUALITY ASSURANCE
A. Documentation: Comply with the following:
   2. Minimum text size: 1/8 inch
   3. Legible when microfilmed
   4. Other requirements of AHJ
B. Design requirements specific to Delegated Design portions are indicated in Drawings and in Sections that specify the component.
C. Engineer’s 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.
D. Pre-Submittal Meeting: Contractor shall meet with Architect, Consultant, and Delegated Designer to discuss requirements of work-portion, submittals, scheduling and sequencing.

1.07 SCHEDULING
A. Schedule design process and submittals required for Delegated Design portions to fit within Construction Schedule.
DELEGATED DESIGN PROCEDURES

B. Allow adequate time for AHJ review. Contact AHJ for time estimate and coordination of schedule.

C. If Architect’s approval of Shop Drawings is required prior to application for permit, schedule and sequence Shop Drawing review prior to review of permit submittal. Allow time specified in Section 01 33 00.

END OF SECTION
PART 1 GENERAL

1.01 PROJECT GOALS

A. This project has been designed to achieve the LEED-NC Gold (minimum 60 points) rating, as defined in the LEED(r) Green Building Rating System for New Construction and Major Renovations, 2009 Edition.

B. Contractor is not responsible for the application for LEED certification, nor for determination of methods of achieving LEED credits unless specifically so indicated.

C. Many of the LEED credits can be achieved only through careful design of the project which is not the responsibility of the Contractor. However, certain credits relate to the products and procedures used for construction. The full cooperation of the Contractor and subcontractors is essential to achieving the LEED goal.

D. Contractor shall familiarize themselves with the relevant requirements and provide the necessary information and instruction to subcontractors and installers.

E. This Section includes a summary of requirements and procedures intended to achieve LEED credits.
   1. Some credits are marked PREREQUISITE; these must be achieved regardless of the level of certification; many are dependent on proper performance by Contractor and subcontractors.
   2. Some credits involve quantifying percentages by weight and cost; these require careful recordkeeping and reporting by the Contractor.

F. LEED Reporting: Credits are achieved after properly executed reports are accepted by USGBC. This Section identifies the LEED Credits for which Contractor shall execute LEED Credit Reports.

G. Abbreviations and Symbols:
   2. LEED: Leadership in Energy and Environmental Design, a registered trade mark of USGBC.
   3. LEED Letter Template: USGBC form that is executed by the responsible party identified in LEED Checklist or this Section. LEED Letter Templates are executed via internet at https://leedonline.usgbc.org/Login.aspx.
   4. NC: New Construction (or major renovation).
   5. CI: Commercial Interiors.
   6. SS: Sustainable Site.
   7. WE: Water Efficiency.
   9. MR: Materials and Resources.
   10. EQ: Indoor Environmental Quality.
   11. ID: Innovation and Design process. ID credits are identified as "ID 1.#" because they cannot be verified and numbered until all applicable information is available.

1.02 CONTRACTOR'S RESPONSIBILITIES

A. Achieving some LEED Prerequisites are entirely Contractor's responsibility. They are:
   1. SS Prerequisite 1, Erosion and sedimentation control plan during construction, Section 01 57 13.
   2. EA Prerequisite 3, Assure zero use of CFC's, prohibited in Section 01 60 00 and Division 23.

B. Achieving some LEED Credits are entirely Contractor's responsibility. They are:
   1. MR 2.1 and M2.2, Construction waste management. Specific requirements are specified in Section 01 74 19.
   2. IEQ 3.1 and IEQ 3.2, Construction indoor air quality management plan during construction and before occupancy. Requirements are specified in Section 01 57 21.
LEED CERTIFICATION PROCEDURES

3. IEQ 4.1, IEQ 4.2, IEQ 4.3, and IEQ 4.4, Low-emitting materials. Contractor shall assure that products used in this Project comply with requirements. Specific requirements are summarized in Section 01 60 00.

C. Some LEED Credits require Contractor's assistance to select products that comply with LEED requirements. These credits include:
   1. EA 4, Montreal Protocol Early Compliance. Assure zero use of CFC’s, HCFC’s and Halon.
   4. MR 5.1 and MR 5.2, Regional Materials. Select products that are extracted and manufactured within Project region.
   5. MR 6, Rapidly renewable materials. Select product made from rapidly renewable materials.
   6. MR 7, Certified wood. Select wood products made from certified wood.

D. Contractor shall assist Owner to achieve as many LEED Credits as possible.

E. Anticipated Credits: Contractor shall comply with Contract Documents and LEED requirements for credits reviewed during the design phase and designated "Anticipated" by USGBC.
   1. Substitutions: Contractor shall assure that substitute products or methods for work in Anticipated credits comply with LEED requirements.

1.03 SUBMITTALS TO USGBC

A. Credits are awarded when properly executed and documented LEED Letter Templates are submitted and accepted by USGBC. When supporting documentation is ready, the responsible party shall execute the appropriate LEED Letter Template, sign the template, submit (upload) the template with documentation, and respond to USGBC comments or requests until the credit is awarded.
   2. Owner's LEED consultant will initiate review of LEED credits by USGBC upon receiving completed documentation for all credits from responsible parties.
   3. USGBC review staff will require clarification for LEED credits where documentation is incomplete, unclear or incorrect.
   4. Owner's LEED Consultant will inform responsible party to respond to USGBC comments or requests until the credit is awarded.

B. Contractor shall upload to LEED Online the completed LEED Letter Templates and support documentation for the following credits:
   1. SS Prerequisite 1, Construction Activity Pollution:
      a. LEED Letter Template.
      b. Erosion and sedimentation control plan.
      c. Drawings documenting erosion and sedimentation control measures.
   2. MR 2, Construction Waste Management:
      a. LEED Letter Template.
      b. Documentation of waste hauling certificates.
      c. Construction Waste Management Plan. Specific requirements are specified in Section 01 74 19.
   3. MR 3, Materials Reuse:
      a. LEED Letter Template.
      b. Documentation for materials contributing towards achievement of this credit.
   4. MR 4, Recycled Content:
      a. LEED Letter Template.
      b. Documentation for all materials contributing towards achievement of this credit.
   5. MR 5, Regional Materials:
      a. LEED Letter Template
      b. Documentation for all materials contributing towards achievement of this credit.
6. MR 6, Rapidly Renewable Materials:
   a. LEED Letter Template.
   b. Documentation for all materials contributing towards achievement of this credit.

7. MR 7, Certified Wood:
   a. LEED Letter Template.
   b. Chain-of-Custody certificates for all wood products contributing towards achievement of this credit.

8. EQ 3.1, Construction IAQ Management - During Construction:
   a. LEED Letter Template.
   b. Construction IAQ Management Plan. Specific requirements are specified in Section 01 57 21.
   c. Narrative and photographs demonstrating compliance with Construction IAQ Management Plan.
   d. If the HVAC system is run during construction, cut sheets or manufacturers data on filtration media installed during construction.

9. EQ 3.2, Construction IAQ Management - Before Occupancy:
   a. LEED Letter Template.
   b. Indoor Air Quality testing report if Indoor Air Quality testing was performed for credit compliance.
   c. Narrative describing the specific flush out procedures of IAQ testing process.
   d. Specific requirements for IAQ testing and building flush out procedures are specified in section 01 57 21.

10. EQ 4.1, Low-Emitting Materials - Adhesives and Sealants:
    a. LEED Letter Template
    b. List adhesives and sealants installed inside the weather resistive barrier including the manufacturer, VOC content and quantity used.

11. EQ 4.2, Low-Emitting Materials - Paints and Coatings:
    a. LEED Letter Template
    b. List of all paints and coatings installed inside the weather resistive barrier including the manufacturer, VOC content and quantity used.

12. EQ 4.3, Low-Emitting Materials - Carpet Systems:
    a. LEED Letter Template
    b. List of carpet products, cushions and adhesives installed in the building, and confirmation that all comply with the CRI Green Label Plus testing program.

13. EQ 4.4, Low-Emitting Materials - Composite Wood, Agrifiber Products, and Laminating Adhesives:
    a. LEED Letter Template
    b. List of composite wood and agrifiber product installed inside the weather resistive barrier and confirmation that each product does not contain added urea-formaldehyde.
    c. List laminating adhesives for both shop and field use, and confirmation that each product does not contain urea-formaldehyde.

C. In the event that a credit is audited during the review by USGBC, submit information requested.

1.04 RELEVANT SECTIONS
   A. Section 01 33 00 - Submittal Procedures: for procedures and submittal cover sheet that is required with each submittal.
   B. Section 01 60 00 - Product Requirements: includes LEED credit requirements for products.
   C. Section 01 57 13 - Temporary Erosion and Sediment Control.
   D. Section 01 57 21 - Indoor Air Quality Controls:
      1. Testing of ventilation; EQ Credit 2.
      2. Contractor's IAQ management plan and construction procedures; EQ Credit 3.1.
      3. Building flush out or air contaminant testing; EQ Credit 3.2.
E. Section 01 74 19 - Construction Waste Management and Disposal specifies requirements for construction waste management credits.
F. Section 01 91 13 - General Commissioning Requirements, and commissioning Sections in other Divisions.
G. Individual Sections of Divisions 02 through 10 include specific submittal requirements and product requirements.

1.05 SUBMITTALS
A. Comply with Section 01 33 00 - Submittal Procedures.
B. LEED Submittal/Report: For each product with the notation "show quantity on LEED submittal or report," submit a report with the following information:
   1. Submit with each Application for Payment; update the Report each period with latest period shown separately:
   2. Identify each product with:
      a. Name and manufacturer.
      b. Location of manufacturer and source of materials.
      c. Specification Section number.
      d. Applicable Credit(s).
      e. Net weight per unit.
      f. Quantity installed.
      g. Material cost per unit.
      h. Total material cost.
      i. Other information specified for specific item.
   3. Attach evidence of compliance from either the manufacturer or an independent agency.

1.06 INFORMATION SOURCES
B. Bay Area Air Quality Management District (BAAQMD); 939 Ellis Street, San Francisco, California 94109. Tel: (415) 771-6000. www.baaqmd.gov.
D. Center for Resource Solutions (CRS); Presidio Building, 49 P.O. Box 29512, San Francisco, CA 94129. Tel: (415) 561-2100. Fax: (415) 561-2105. www.resource-solutions.org or www.green-e.org.
F. South Coast Air Quality Management District (SCAQMD); 21865 E. Copley Drive, Diamond Bar, CA 91765. Tel: (909) 396-2000. www.aqmd.gov.

PART 2 PRODUCTS (NOT USED)
PART 3 EXECUTION (NOT USED)

END OF SECTION
## Materials and Resources (14 Possible Points)

<table>
<thead>
<tr>
<th>STRATEGY</th>
<th>CRITICAL QUESTIONS</th>
<th>C</th>
<th>P</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage &amp; Collection of Recyclables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Reuse, 55% of Existing Walls, Floors &amp; Roof</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Reuse, 75% of Existing Walls, Floors &amp; Roof</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Reuse, 95% of Existing Walls, Floors &amp; Roof</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Reuse, 50% of Interior Non-Structural Elements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Waste Management, Divert 50% from Disposal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Waste Management, Divert 70% from Disposal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials Reuse, 95%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials Reuse, 10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Content, 10% (post-consumer + ½ pre-consumer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Content, 20% (post-consumer + ½ pre-consumer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional Materials, 10% Extracted &amp; Manufactured Regionally</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional Materials, 20% Extracted &amp; Manufactured Regionally</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood Shuck?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCL/SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PART 1 GENERAL

1.01 SECTION INCLUDES

A. References and standards.
B. Quality assurance submittals.
C. Mock-up.
D. Control of installation.
E. Tolerances.
F. Testing and inspection services.
G. Manufacturers’ field services.

1.02 REFERENCE STANDARDS


1.03 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
C. Mock-Up: Full-size, physical assemblies that are constructed on-site. Mock-ups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.
   1. Approved mock-ups establish the standard by which the Work will be judged.
D. Laboratory Mock-up: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.
E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of 10 previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.04 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of Contract Documents, unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on the Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
   1. When copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.
   2. When copies of standards are needed for any reason, obtain copies directly from publication source.

D. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list.
   1. ADAAG or ADAAmericans with Disabilities Act
   2. CFRCODE of Federal Regulations
   3. DODDepartment of Defense Military Specifications and Standards
   4. FSFederal Specification
   5. MILSPECMilitary Specification and Standards
   6. UFASUniform Federal Accessibility Standards

E. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

1.05 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.06 SUBMITTALS

A. Reports: Prepare and submit certified written reports that include the following:
QUALITY REQUIREMENTS

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.
14. Distribution: Contractor, Architect, Engineer of Record, Authority Having Jurisdiction, Owner (verify), and Construction Manager (when appropriate).

B. Deficiencies Report: Attach a separate list of deficiencies identified in previous reports that have not been corrected and successfully retested.
   1. Submit a final report certifying the status of all deficiencies, signed and stamped. Submit report directly to Authority having jurisdiction (when required) and copy to others.

C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

D. Testing Agency Qualifications:
   1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.

1.07 TESTING AND INSPECTION AGENCIES

A. Owner will employ and pay for services of an independent testing agency to perform specified testing and inspection.
   1. Owner's testing agent will perform "special inspections" required by Regulations.

B. Contractor shall employ and pay for services of an independent testing agency to perform other testing and inspection specified as Contractor's responsibility or required by Contractor for quality control.

C. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

D. Contractor Employed Agency:
   2. Inspection agency: Comply with requirements of ASTM D3740 and ASTM E329.
   3. Laboratory: Authorized to operate in the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
QUALITY REQUIREMENTS

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have Work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.
   1. Design anchorage and attachments to resist seismic forces when required by Regulations.

3.02 MOCK-UP

A. Before installing portions of the Work requiring mockups, build mock-up for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mock-up in location and of size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mock-up will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship.
   4. Obtain Architect's approval of mock-up before starting work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of mock-up.
   5. Maintain mock-up during construction in an undisturbed condition as a standard for judging the completed Work.

B. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.

C. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

D. Accepted mock-up shall be a comparison standard for the remaining Work.

E. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, remove mock-up and clear area when directed to do so.
   1. Deconstruct and recycle mock-up that is not incorporated in Work.

3.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION

A. Testing Agency Duties:
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertained compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.

B. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
QUALITY REQUIREMENTS

2. Agency may not approve or accept any portion of the Work.
3. Agency may not assume any duties of Contractor.
4. Agency has no authority to stop the Work.

C. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

D. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.

E. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

F. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect. Payment for re testing will be charged to the Contractor by deducting testing charges from the Contract Price.

3.05 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Architect 30 days in advance of required observations.
   1. Observer subject to approval of Architect.

C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not conforming to specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace Work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. References and standards.
B. Quality assurance submittals.
C. Free standing Mock-ups.
D. Control of installation.
E. Tolerances.
F. Testing and inspection services.
G. Building envelope testing.
H. Manufacturers' field services.

1.02 REFERENCE STANDARDS

A. Laboratory Test Methods:
   1. ASTM E 283-9, Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors.
B. Field Test Methods:
   1. ASTM E 783-02, Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
   2. ASTM E 1105-00 - Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
   3. ASTM E 1186-03 - Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
   4. AAMA 501.2-03 - Field Check of Metal Storefronts, Curtain Walls, and sloped Glazing Systems for Water Leakage.
   5. Material Standards:
      b. ASTM E 774 - Standard Specification for the Classification of the Durability of Sealed Insulating Units.
      c. AAMA 2605-98 - Superior Performing Organic Coating on Aluminum Extrusions and Panels

1.03 DEFINITIONS

A. Defective materials and workmanship include, but are not limited to, evidence of:
   1. Penetration of water into or through mockup.
   2. Air infiltration exceeding specified limits.
   3. Delamination of wall insulated glass units.
   4. Cracking, crazing, flaking of coatings or opacifiers on glass.
   5. Discoloration or fading, excessive non-uniformity, pitting, cracking, peeling, crazing, or corrosion of surfaces.
   7. Secondary glass damage due to failing building skin components.
   8. Warping, racking, or movement out of plane of metal or metal composite wall panels.
   9. Shearing, popping, or movement of fasteners, concealed or exposed.
   10. Warping, racking, or movement out of plane of window frames.
11. Operable window units that bind, stick, or do not operate smoothly.
12. Adhesive or cohesive failure of sealants.
13. Crazing on surface of sealants.
14. Sealant hardening beyond Shore A durometer 50 or softening below 20.
15. Chipping or spalling of concrete.

1.04 MOCK-UP SUMMARY
A. Two free standing mock-ups are required to be constructed apart and separated from the project itself. Mock-ups shall represent the products on the project and procedures used for installing all finishes, materials, and equipment listed.
   1. Mock-up two shall be used for material testing.
B. Provide enclosures (as needed) to protect mock-ups from exposure to the elements.
C. Location: On or off site at location agreed to by Owner and Contractor.
D. Mock-ups may not remain as part of the work. Remove all mock-ups and clear area when directed or at project completion.
E. Mock-ups are to be constructed out of sequence with the project itself. Track building of the mock-up on the construction schedule and follow procedures for submittals for approval of all items being mocked-up prior to building the mock-up.

1.05 SYSTEM PERFORMANCE REQUIREMENTS
A. Purpose:
   1. Building mockup is to demonstrate that materials and systems forming exterior shell of Project meet or exceed performance requirements specified in the individual specification sections and to meet code requirements for the location of the project.
B. Materials and systems that fail to contribute to formation of a water-tight and air-tight exterior shell, or that show excessive stress, weathering, discoloration, or weakness, shall be re-evaluated for use in the Project.

1.06 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Submit shop drawings for fabrication and installation two weeks prior to construction of building mockup.
   2. Provide the following:
      a. Site location drawing, showing Building Mockup on site, access roads, north arrow, and drawing scale.
      b. Floor Plan: 1/2 inch scale.
      c. Wall Elevations: 1/4 inch scale.
      d. Wall Sections: 3/4 inch scale.
      e. Half size details of conditions for every member, joint, anchorage, weld size, glazing system, wall panel system, and provisions for expansion and contraction and sealant application.
      f. Isometric details to completely describe items being proposed by subcontractor involved, or as requested by Architect.
      g. Coordination details for related and adjoining Work. Insert templates, and erection diagrams to completely describe and construct Building Mockup.
      h. Glazing Sections:
         1) Show dimensions, including but not limited to, section thicknesses, frame lap over glass, and edge clearance.
         2) Show tolerances for dimensions including but not limited to field dimensions, mill and shop dimensions, and glass dimensions.
      i. Wall Panel Sections:
         1) Show dimensions, including but not limited to, section thicknesses, and edge clearance.
2) Show tolerances for dimensions including but not limited to field dimensions, mill and shop dimensions, and panel dimensions.

j. Enclosures and Accommodations for Test Equipment:
1) Comply with ASTM E 1105.
2) Show calculations ensuring enclosures are designed to withstand pressures and test conditions of testing.

C. Structural calculations sealed and signed by a Professional Engineer responsible for their preparation and registered in the State in which the project is located.
1. Show ultimate factor of safety.
2. Prepare calculations in accordance with more stringent of current design rules of Aluminum Association, AISC, AISI, ACI, or these Project Specifications.

1.07 QUALITY ASSURANCE
A. Comply with technical specification section for each material included in Building Mockup, and for administration and coordination requirements specified.
B. Duplicate conditions and methods proposed for final construction.
C. Make a video recording of assembly methods used for construction of building mockup. Comply with submittal procedures in Section 01 30 00 - Administrative Requirements.

1.08 PROJECT CONDITIONS
A. Environmental Conditions: Do not proceed with Building Mockup construction when ambient temperature and substrate conditions are outside limits permitted by the specified products systems specified.

PART 2 PRODUCTS
2.01 MOCK-UP ONE: EXTERIOR
A. Mock-up shall be constructed to represent and identify aesthetic standards, expectations for workmanship, sequence of installation, coordination with surrounding work, and to ensure that manufacturer's processes for the individual portions of the work listed below conform to the overall project goals. Mock-ups so indicated will also be used to test that products and installation conform to the performance requirements listed in each Section.
1. Mock-up is to be approximately 15 feet wide by 25 feet long and one story high to represent an exterior corner, interior corner, all window and curtain wall conditions, and all typical exterior wall conditions. A drawing showing exact scope for the mock-up will be issued by the Architect referencing details and conditions documented in the drawings.
2. Mock-up is to be reviewed for the following:

B. 03 30 00; CAST-IN-PLACE CONCRETE
1. Concrete Finish; Suitability as a substrate for finish materials.
2. Repair Materials; Sequence and coordination.

C. 03 35 19; HARDENED AND POLISHED CONCRETE
1. Concrete Finish; Aesthetics.

D. 04 20 01; MASONRY VENEER
1. Masonry; Aesthetics, installation techniques, and coordination with other trades.

E. 05 12 00; STRUCTURAL STEEL FRAMING
1. Ledger and Canopy; Installation techniques and coordination.
2. Include paint on canopy steel for mock-up.

F. 05 31 00; STEEL DECKING
1. Canopy Decking; Aesthetics and coordination.
2. Include paint on steel deck mock-up.

G. 05 40 00; COLD-FORMED METAL FRAMING
1. Metal Framing; Installation techniques and coordination.

H. 06 10 00; ROUGH CARPENTRY
1. Framing; Installation techniques and coordination.
COORDINATED MOCKUPS

I. 06 16 63; MOISTURE RESISTANT GYPSUM SHEATHING
   1. Sheathing; Installation techniques and coordination.

J. 07 14 00; FLUID-APPLIED WATERPROOFING
   1. Waterproofing; Installation techniques and coordination.
   2. Waterproofing system to be tested.

K. 07 19 00; WATER REPELLENTS
   1. Water Repellents; Installation techniques, aesthetics, and coordination.

L. 07 25 09; SELF-ADHERED MEMBRANE
   1. Self-adhered Membrane; Installation techniques and coordination.
   2. Waterproofing system to be tested.

M. 07 42 00; METAL WALL PANELS
   1. Wall Panels; Installation techniques, aesthetics, and coordination.

N. 07 46 46; FIBER CEMENT SIDING
   1. Wall Panels; Installation techniques, aesthetics, and coordination.
   2. Flashing and Trim associated with other systems within the mock-up;

O. 07 62 00; SHEET METAL FLASHING AND TRIM
   1. Flashing and Trim associated with other systems within the mock-up; Installation techniques and coordination.

P. 07 84 00; FIRESTOPPING
   1. Firestopping (at curtain wall and slabs); Installation techniques and coordination.

Q. 07 90 05; JOINT SEALERS
   1. Joint Sealers and Accessories; installation techniques and coordination.

R. 08 44 13; GLAZED ALUMINUM CURTAIN WALLS
   1. Curtain Wall System; installation techniques, aesthetics, and coordination with supports and other surrounding construction.
   2. Include glazing, transom and louver infill on mock-up.
   3. Curtain Wall system to be tested.

S. 08 53 13; VINYL WINDOWS
   1. Windows; installation techniques, aesthetics, and coordination with surrounding construction.
   2. Include glazing on mock-up.
   3. Windows to be tested.

T. 09 24 00; PORTLAND CEMENT PLASTERING (STUCCO)
   1. Wall Panels; Installation techniques, aesthetics, and coordination.

U. 22 21 13; PIPE AND PIPE FITTINGS PLUMBING
   1. Roof Drains, Overflow Drains, and Hose Bibb; installation techniques, aesthetics, and coordination.

V. 23 31 01; HVAC DUCTS AND CASING-LOW PRESSURE
   1. Termination Points; installation techniques and coordination.

2.02 MOCK-UP TWO: INTERIOR

A. Interior Mock-up is to be constructed to represent a complete and functional interior dwelling unit for marketing, general layout, and overall aesthetic review. The mock-up is to represent a single full scale dwelling unit including lighting and mechanical equipment but without full infrastructure for a fully functional mechanical and plumbing system. The interior mock-up is to be professionally cleaned and shall represent a dwelling unit ready for Final Completion including windows, kitchen appliances, cabinets, bathroom plumbing and bathroom fixtures, and all interior finishes indicated in the construction documents.
   1. Refer to the drawings for the full scope of details and conditions required.
   2. A punch list of the interior unit shall be provided prior to acceptance.
PART 3 EXECUTION

3.01 GENERAL
A. See Section 01 40 00 for additional requirements.

3.02 PREPARATION
A. Provide the following to facilitate testing:
   1. Building Mockup Test Chamber: Construct of steel studs and plywood or drywall (interior grade acceptable).
      a. Steel studs, top and bottom track, stud spacing and fastening to be constructed as typical exterior walls.
      b. Sheathing installed exterior side of chamber.
      c. Access hatch (approximately 2 x 3 feet) to allow chamber entrance and exit, and to be operable and sealed for air leakage.
      d. Fire caulk or fire tape board joints to adjacent concrete slabs and columns and/or exterior walls.
         1) Chamber to be sealed to exterior beyond edge of test section.
      e. Install selected curtain wall and window walls:
         1) Install system complete with interior and exterior seals including tie-ins to adjacent systems.
         2) Adjacent systems to sealed, to six (6) feet beyond edge of test chamber.
   2. Water supply requirement to test chamber location:
      a. 21 gallons per minute at 15 psi.
      b. Connecting larger hose (greater than 1-1/2 inch) and splitting to two(2) 3/4 inch hoses at test may also be sufficient.
      c. Length of hose exceeding 250 feet: Plastic piping to be used to minimize pressure loss due to higher friction of rubber hose.
      d. Electricity: One dedicated 20 amp circuit.

3.03 TESTING
A. Owner to engage qualified independent Testing Agency to perform testing of Building Mockup.
B. Water Penetration:
   1. Test installed systems at locations and to extent indicated by Architect.
   2. Perform minimum of one (1) water test by method specified in ASTM E 1105.
   3. Testing to evaluate watertightness of intersections of systems as well as each individual system.
      a. Testing windows for water infiltration to be conducted with window manufacturer's representative present
      b. Areas to include but not limited to:
         1) Fixed and operable windows.
         2) Cladding systems.
         3) Penetrations.
      c. Durations: Four (4) cycles of five (5) minutes each with one (1) minute of neutral pressure between cycles.
C. Notify Architect and Owner, in writing, minimum of 14 days prior to conducting field testing.

3.04 REPAIR AND RETESTING
A. Repair or remove Work that does not meet specified requirements, or that is damaged by testing.
   1. Where repair does not produce system(s) that meet specified performance requirements, replace system(s) components with new components and re-test.
   2. Obtain Architect's acceptance of corrective Work prior to executing it.
B. Cost of corrective Work and re-testing necessary to arrive at performance requirements are Contractor's responsibility.
   1. Re-testing includes testing fees, Architect's fees, and Consultant's fees.
a. Re-testing costs due to re-design by Architect will be paid by Owner.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Measuring moisture vapor emission of new concrete floors.
   1. Calcium Chloride (CaCl2) Test.
   2. In-situ Relative Humidity Test.

B. Measuring alkalinity (pH) of new concrete floors.

1.02 RELATED SECTIONS

A. Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Section 01 40 00 - Quality Requirements for quality assurance, laboratory responsibilities and laboratory reports.
C. Section 01 50 00 - Temporary Facilities and Controls: Temporary heating, cooling and ventilating.
D. Section 03 30 00 - Cast-In-Place Concrete; for substrate to be tested.

1.03 REFERENCES

A. ASTM F 1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

1.04 PERFORMANCE REQUIREMENTS

A. Provide suitable concrete floor substrate for application of finish floor systems that will meet finish floor manufacturer's installation requirements.

B. Moisture vapor emission testing:
   1. Moisture dome testing (calcium chloride test):
      a. Moisture vapor test results to achieve three pounds per 1,000 square feet of concrete floor surface per 24 hours, or as allowed by flooring (or adhesive) manufacturer, when tested in conformance with ASTM F 1859.
   2. In-situ relative humidity test:
      a. In-situ relative humidity test results to achieve relative humidity reading of no greater than 75 percent or as allowed by flooring (or adhesive) manufacturer, when tested in conformance with ASTM F 2170.

C. Concrete slab surface pH testing:
   1. Alkalinity testing with probe or pH testing paper to achieve an alkalinity pH no more than 7 and no greater than 9 or as allowed by flooring (or adhesive) manufacturer when tested in conformance with ASTM F 710.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's product data for all testing materials proposed for Work of this Section.
B. Letter of Verification of Environmental Conditions as below.
C. Test Reports: Submit moisture vapor emission and alkalinity test reports in accordance with requirements of Section 01 30 00.

1.06 ENVIRONMENTAL CONDITIONS

A. Prior to testing for moisture vapor emissions rate, space shall be enclosed, fully weather-tight, wet work shall be complete and normally dry, work above ceilings finished. The test site shall be at the same temperature and humidity expected during normal use.

B. Building Temperature: Minimum 65 degrees F. Maximum 85 degrees F.
C. Interior Relative Humidity: Minimum 40 percent. Maximum 60 percent.
D. Maintain specified environmental conditions not less than 72 hours prior to conducting tests and throughout duration of the tests.
1.07 QUALITY CONTROL
   A. Testing shall be conducted not less than 120 days after date of last pour of concrete slab to be tested.
   B. Quantity of Tests Required:
      1. Not less than 3 test are required for the first 1,000 square feet plus one test per each additional 1,000 square feet or fraction thereof.

PART 2 PRODUCTS
2.01 MOISTURE VAPOR EMISSION TESTING
   A. Moisture Dome Testing: Conform to requirements of ASTM F 1869.
      1. Anhydrous Calcium Chloride (CaCl₂) Test Kits: Kits shall contain a plastic spherical dome with a factory installed silicone gasket, weight ring, airtight foil bag of calcium chloride (approximately 30 grams), and a plastic dish with snap-top lid and label.
         a. This test requires use of a gram-weight scale with a gradation of 1/10th (0.1) gram.
      2. Approved Manufacturers:
         b. Other manufacturers: Comply with Section 01 60 00 - Product Requirements.
   B. In-situ Relative Humidity Testing is required to be performed by an independent testing laboratory using relative humidity moisture meter kits and sensors conforming to requirements of ASTM F 2170.

2.02 CONCRETE SLAB SURFACE PH TESTING
   A. pH Tester with a surface probe.
   B. pH Test Kits: Kits shall contain pH paper, pH pencil and pH color chart for comparison.

PART 3 EXECUTION
3.01 PREPARATION
   A. General:
      1. Prior to testing, verify that environmental conditions have been met.
      2. Heating ventilating and air conditioning system is operating or temporary heat, cooling and ventilating system is operating.
      3. Lay Out Test Area: Measure the space to be tested. Layout the test sites in a rectangular, quasi rectangular or a cross-diagonal grid. Come in 5 feet from any exterior wall and place test kits at even intervals. Complete the grid. Record the location of each test site on a Record Drawing.
   B. Moisture Dome Testing:
      1. Surface Preparation:
         a. For each test area, expose a surface area of 20 inches square.
         b. Grind or sand the concrete surface. Test area shall be clean and free of all foreign substances; including curing compounds, sealers, paint, oil, resins, parting compounds, floor leveling compounds, dirt, etc.
      2. After surface preparation is complete and prior to testing, allow space to remain undisturbed for 24 hours.
   C. In-situ Relative Humidity Test:
      1. Drill 5/8 inch diameter test site holes to a depth equal to 40 percent of the slab’s thickness for slabs on grade and 20 percent for elevated slabs.

3.02 TESTING
   A. Using a vacuum, remove any dust or dirt from concrete surface where moisture dome test kit is to be placed or in the case of an in-situ relative humidity test clean debris from hole then insert plastic sleeve and cap sleeve. Do not use solvents or water to clean the concrete.
   B. Moisture Dome Testing: Perform in accordance with requirements of ASTM F 1869.
1. Install moisture vapor emission test kits according to manufacturer's published instructions.
2. Test results are sensitive to testing procedures. Take care to follow manufacturer's instructions.
3. Allow test kits to remain in place undisturbed for 60 to 72 hours.

C. In-situ Relative Humidity Test: Perform testing in accordance with requirements of ASTM F 2170.
   1. Allow probe sensor at each test site 72 hours equilibration time prior to reading relative humidity levels.
   2. After equilibration, take a probe into the sleeve and obtain relative humidity level readings from the bottom of the hole.
   3. Testing density is required to equal 3 tests in the first 1,000 square feet, with one additional test per each additional 1,000 square feet of concrete slab surface.
   4. Once satisfactory relative humidity testing results are achieved, patch testing site holes prior to application of finish flooring.

D. Alkalinity Testing Using pH Tester:
   1. Conduct test adjacent each location of test for moisture vapor emission.
   2. With the concrete already clean, pour approximately 2 tablespoons of distilled water onto surface of concrete.
   3. Allow distilled water to stand for approximately 3 minutes. While waiting, lightly stir water to help it absorb any of the salts.
   4. Place tip of surface probe into the distilled water solution to obtain results.

E. Alkalinity Testing Using pH Paper:
   1. Conduct test adjacent each location of test for moisture vapor emission.
   2. With the concrete already clean, pour approximately 2 tablespoons of distilled water onto surface of concrete.
   3. Allow distilled water to stand for approximately 3 minutes. While waiting, lightly stir water to help it absorb any of the salts.
   4. After the allotted time, place a pH paper into the distilled water solution and then compare the color changes in the paper with the pH chart to obtain results.

F. Record data and results and submit in accordance with Section 01 30 00.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary utilities.
B. Temporary telecommunications services.
C. Temporary sanitary facilities.
D. Temporary Controls: Barriers, enclosures, and fencing.
E. Security requirements.
F. Vehicular access and parking.
G. Waste removal facilities and services.
H. Project identification sign.
I. Field offices.

1.02 TEMPORARY AND CONSTRUCTION UTILITIES

A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.
B. Existing facilities may not be used.
C. New permanent facilities may be used.
D. Use trigger-operated nozzles for water hoses, to avoid waste of water.
E. All shut-off locations are to be documented for emergency purposes prior to pre-construction meeting.
F. Documentation of locations is to be distributed to PM, Facilities Zone Supervisor, DPS, EH&S, and any others determined by individual projects.

1.03 TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.
B. Telecommunications services shall include:

1.04 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
B. Maintain daily in clean and sanitary condition.

1.05 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.06 FENCING

A. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.07 EXTERIOR ENCLOSURES

A. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.
1.08 INTERIOR ENCLOSURES
   A. Provide temporary partitions and ceilings as indicated to separate work areas from
      Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas,
      and to prevent damage to existing materials and equipment.
   B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and
      sealed edges at intersections with existing surfaces.

1.09 SECURITY AND ACCESS TO CONSTRUCTION SITES
   A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from
      unauthorized entry, vandalism, or theft.
   B. DPS and PM are to be consulted to determine strategies to be implemented.
   C. UO Fire Marshal and EH&S consultation regarding egress routes from the project site and
      adjacent buildings to be provided and maintained at all times.
   D. ADA routes must be provided and maintained at all times from the site & adjacent buildings.
   E. Parking within site fencing is controlled and managed by the GC.
   F. If the project does not have site fencing then parking is restricted by issued parking permits
      through DPS in designated locations only. Parking permits are requested of DPS by the PM.

1.10 VEHICULAR ACCESS AND PARKING
   A. Coordinate access and haul routes with governing authorities and Owner.
   B. Provide and maintain access to fire hydrants, free of obstructions.
   C. Provide means of removing mud from vehicle wheels before entering streets.
   D. Provide temporary parking areas to accommodate construction personnel. When site space is
      not adequate, provide additional off-site parking.

1.11 WASTE REMOVAL
   A. Provide waste removal facilities and services as required to maintain the site in clean and
      orderly condition.
   B. Provide containers with lids. Remove trash from site periodically.
   C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable
      non-combustible containers; locate containers holding flammable material outside the structure
      unless otherwise approved by the authorities having jurisdiction.
   D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers
      with lids.

1.12 PROJECT IDENTIFICATION
   A. Provide project identification sign of design and construction indicated on Drawings.
   B. Erect on site at location indicated.
   C. No other signs are allowed without Owner permission except those required by law.
   D. Only two types of signs fixed to construction fencing are allowed:
   E. One sign to identify the project, project purpose, project rendering and design team.
   F. One sign to list the general and sub-contractors.

1.13 FIELD OFFICES
   A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped
      with sturdy furniture, drawing rack and drawing display table.
   B. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
   C. Locate offices a minimum distance of 30 feet from existing and new structures.
TEMPORARY FACILITIES AND CONTROLS

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. This Section includes the following:
   1. Protection of existing trees from damage.

1.2 DEFINITIONS
A. Designated Trees: As indicated on Drawings.
B. Critical Root Zone (CRZ): The CRZ for trees 4 inches in caliper or smaller shall be an area
   with a radius at least 5 feet from the trunk. The CRZ for trees over 4 inches in caliper shall be
   an area with a radius of at least 1 foot 6 inches from the trunk for every 1 inch of caliper size.
C. Zone of Protection: CRZ and as indicated on Drawings.

1.3 POSTING
A. When directed, post Designated Trees with Notice sign provided by Owner's Representative.
   Attach sign to tree with twine or staples, no nails. Maintain and protect the Notice sign until
   completion of construction. Obtain approval of Owner's Representative prior to removal of
   sign.

1.4 NOTICE
A. Notify all workers, including subcontractors, of the requirements to protect Designated Trees
   using Notice provided.

1.5 PROTECTIVE FENCING
A. Install protective fencing around Designated Trees and where shown on Drawings prior to
   commencement of any work. Fencing to be a minimum 6 foot chain link, with fence posts
   securely anchored. Maintain during construction. Adjustments to fence locations are to be
   approved by the Owner's Representative prior to performing any work within the Zone of
   Protection.

1.6 CONSTRUCTION FENCING
A. No construction activities are permitted within the protective fencing without prior approval of
   the Owner’s Representative.
B. Prior to removal of Construction Fencing perform a mandatory meeting for the remaining
   exterior trades to ensure tree protection measures are met.

1.7 ZONE OF PROTECTION
A. No storage, stockpiling, parking, etc. is permitted within the Zone of Protection.
B. Post notices on fencing listing prohibited activities without prior approval. Notice to remain in
   place until authorization is granted by the Owner's Representative.
C. Submit requests to work within the Zone of Protection to Owner's Representative.
D. The following activities are prohibited in the Zone of Protection without written approval from
   the Owner's Representative:
   1. Removal or moving protective fencing
   2. Parking and driving of vehicles
   3. Storing equipment or materials
   4. Excavations
   5. Flooding and cleanup of equipment, tools, etc.
   6. Operation of equipment
   7. Staging of materials
   8. Trenching
   9. stockpiling
   10. Altering drainage
TEMPORARY TREE AND PLANT PROTECTION

1.8 TRENCHING AND EXCAVATION
   A. All trenching and excavation within the Zone of Protection is to be performed with the use of an air spade or by hand. Obtain Owner’s Representative approval of trenching and excavation locations and methods prior to performing any work.

1.9 ROOT PRUNING
   A. Prune roots encountered during construction with an approved root-pruning device. Make clean, vertical cuts. Do not leave split or frayed ends. Obtain Owner’s Representative approval prior to cutting roots larger than 1 inch in diameter. Backfill exposed roots with specified Planting Soil as soon as practical.

1.10 TREE CANOPY PRUNING
   A. Prune canopies of Designated Trees impacted by construction only upon approval of Owner’s Representative. All canopy pruning must be performed by a certified arborist. Canopy pruning must be approved in advance by consulting arborist hired by Owner.

1.11 MULCH
   A. Provide four (4) inch deep mulch within CRZ and/or Zone of Protection as directed.

1.12 WATERING
   A. Water trees if required by Owner’s Representative. Watering will be required if it is judged that root removal is necessary for construction and threatens the survival of the tree. Use a slow drip or soaker hose to provide one-inch water per week until completion of construction.

1.13 PROHIBITED ACTIVITIES
   A. Cutting of roots larger than 1 1/2 inch diameter or larger without approval.
   B. Damaging tree bark, branches.
   C. Removal of protective fencing or notice posted on trees prior to approval of Owner’s Representative.
   D. Activities prohibited within the Zone of Protection (without prior approval) are, but not limited to: construction, operation of machinery, storage of materials, paving, grading, cutting, filling, travel within, dumping, disposal of liquids, and parking of vehicles or equipment.

1.14 DAMAGE
   A. Actual tree damage such as trunk scoring and broken limbs or damaged roots inside the Zone of Protection will be assessed according to the percentage of loss of tree value. Percentage of tree value will be determined by the Owner’s Representative. Tree value will be determined from “Evaluation of Landscape Trees, Shrubs, and Other Landscape Plants” by International Society of Arboriculture.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prevention of erosion due to construction activities.
B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
C. Restoration of areas eroded due to insufficient preventive measures.
D. Performance bond.
E. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 REFERENCE STANDARDS

G. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit; current edition.

1.03 PERFORMANCE REQUIREMENTS

A. Comply with all requirements of U.S. Environmental Protection Agency for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2003 Construction General Permit (CGP), whether the project is required by law to comply or not.
B. Also comply with all more stringent requirements of State of Oregon Erosion and Sedimentation Control Manual.
C. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.
D. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
   1. Obtain and pay for permits and provide security required by authority having jurisdiction.
   2. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.
E. Provide to Owner a Performance Bond covering erosion and sedimentation preventive measures only, in an amount equal to 100 percent of the cost of erosion and sedimentation control work.
F. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
G. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
   1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.

H. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. Prevent development of ruts due to equipment and vehicular traffic.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

I. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud onto public roads outside site.
   3. Prevent mud and sediment from flowing onto sidewalks and pavements.
   4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

J. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
   2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

K. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

L. Open Water: Prevent standing water that could become stagnant.

M. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Erosion and Sedimentation Control Plan:
   1. Submit not less than 30 days prior to anticipated start of clearing, grading, or other work involving disturbance of ground surface cover.
   2. Include:
      a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
      b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.
      c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.
      d. Schedule of temporary preventive measures, in relation to ground disturbing activities.
      e. Other information required by law.
      f. Format required by law is acceptable, provided any additional information specified is also included.
   3. Obtain the approval of the Plan by authorities having jurisdiction.
   4. Obtain the approval of the Plan by Owner.
C. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.

D. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

E. LEED Prerequisite SS 1: Document construction activity pollution prevention. Comply with Section 01 35 15.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mulch: Use one of the following:
   1. Erosion control matting or netting.

B. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

C. Bales: Air dry, rectangular straw bales.
   1. Cross Section: 14 by 18 inches, minimum.
   2. Bindings: Wire or string, around long dimension.

D. Bale Stakes: One of the following, minimum 3 feet long:
   1. Steel U- or T-section, with minimum mass of 1.33 lb per linear foot.
   2. Wood, 2 by 2 inches in cross section.

E. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
   1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.
   2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491.
   3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355 after 500 hours exposure.
   4. Tensile Strength: 100 lb-f, minimum, in cross-machine direction; 124 lb-f, minimum, in machine direction; when tested in accordance with ASTM D4632.
   5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632.
   6. Tear Strength: 55 lb-f, minimum, when tested in accordance with ASTM D4533.
   7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.

F. Silt Fence Posts: One of the following, minimum 5 feet long:
   1. Hardwood, 2 by 2 inches in cross section.

G. Gravel: See Section 32 11 23 for aggregate.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Construction Entrances: Traffic-bearing aggregate surface.
   1. Width: As required; 20 feet, minimum.
   2. Length: 50 feet, minimum.
   3. Provide at each construction entrance from public right-of-way.
4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Linear Sediment Barriers: Made of silt fences.
   1. Provide linear sediment barriers:
      a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
   2. Space sediment barriers with the following maximum slope length upslope from barrier:
      a. Slope of Less Than 2 Percent: 100 feet.
      b. Slope Between 2 and 5 Percent: 75 feet.
      c. Slope Between 5 and 10 Percent: 50 feet.
      d. Slope Between 10 and 20 Percent: 25 feet.
      e. Slope Over 20 Percent: 15 feet.

D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
   1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
   2. Straw bale row blocking entire inlet face area; anchor into pavement.

E. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.

F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

G. Soil Stockpiles: Protect using one of the following measures:
   1. Cover with polyethylene film, secured by placing soil on outer edges.
   2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches of straw or hay.

H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.

I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

A. Traffic-Bearing Aggregate Surface:
   1. Excavate minimum of 6 inches.
   2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
   3. Place and compact at least 6 inches of 1.5 to 3.5 inch diameter stone.

B. Silt Fences:
   1. Store and handle fabric in accordance with ASTM D4873.
   2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
   3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
   4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
   5. Install with top of fabric at nominal height and embedment as specified.
   6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
   7. Fasten fabric to wood posts using one of the following:
      a. Four 3/4 inch diameter, 1 inch long, 14 gage nails.
      b. Five 17-gage staples with 3/4 inch wide crown and 1/2 inch legs.
   8. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.
C. Straw Bale Rows:
   1. Install bales in continuous rows with ends butting tightly, with one bale at each end of row turned uphill.
   2. Install bales so that bindings are not in contact with the ground.
   3. Embed bales at least 4 inches in the ground.
   4. Anchor bales with at least two stakes per bale, driven at least 18 inches into the ground; drive first stake in each bale toward the previously placed bale to force bales together.
   5. Fill gaps between ends of bales with loose straw wedged tightly.
   6. Place soil excavated for trench against bales on the upslope side of the row, compacted.

D. Temporary Seeding:
   1. When hydraulic seeder is used, seedbed preparation is not required.
   2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
   3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
   4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
   5. Incorporate fertilizer into soil before seeding.
   6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
   7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
   8. Repeat irrigation as required until grass is established.

3.05 MAINTENANCE
   A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.
   B. Repair deficiencies immediately.
   C. Silt Fences:
      1. Promptly replace fabric that deteriorates unless need for fence has passed.
      2. Remove silt deposits that exceed one-third of the height of the fence.
      3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
   D. Straw Bale Rows:
      1. Promptly replace bales that fall apart or otherwise deteriorate unless need has passed.
      2. Remove silt deposits that exceed one-half of the height of the bales.
      3. Repair bale rows that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
   E. Clean out temporary sediment control structures weekly and relocate soil on site.
   F. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP
   A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
   B. Clean out temporary sediment control structures that are to remain as permanent measures.
   C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Construction procedures to promote adequate indoor air quality after construction.
B. Building flush-out after construction and before occupancy.
C. Testing indoor air quality after completion of construction.
D. Testing air change effectiveness after completion of construction.

1.02 PROJECT GOALS
A. Dust and Airborne Particulates: Prevent deposition of dust and other particulates in HVAC ducts and equipment.
   1. Cleaning of ductwork is not contemplated under this Contract.
   2. Contractor shall bear the cost of cleaning required due to failure to protect ducts and equipment from construction dust.
B. Airborne Contaminants: Procedures and products have been specified to minimize indoor air pollutants.
   1. Furnish products meeting the specifications.
   2. Avoid construction practices that could result in contamination of installed products leading to indoor air pollution.
C. Ventilation: HVAC system has been designed to achieve the minimum requirements for ventilation specified in ASHRAE 62.1 with air change effectiveness of 0.9 or greater.

1.03 REFERENCE STANDARDS
A. ASHRAE Std 62.1 - Ventilation For Acceptable Indoor Air Quality; 2012.

1.04 DEFINITIONS
A. Adsorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, fabrics, fibrous insulation, and other similar products.
B. Contaminants: Gases, vapors, regulated pollutants, airborne mold and mildew, and the like, as specified.
C. IAQ: Indoor Air Quality.
D. Particulates: Dust, dirt, and other airborne solid matter.
E. Wet Work: Concrete, plaster, coatings, and other products that emit water vapor or volatile organic compounds during installation, drying, or curing.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Indoor Air Quality Management Plan: Describe in detail measures to be taken to promote adequate indoor air quality upon completion; use SMACNA IAQ Guidelines for Occupied Buildings Under Construction as a guide.
   1. Submit not less than 60 days before enclosure of building.
   2. Identify potential sources of odor and dust.
   3. Identify construction activities likely to produce odor or dust.
   4. Identify areas of project potentially affected, especially occupied areas.
   5. Evaluate potential problems by severity and describe methods of control.
   6. Describe construction ventilation to be provided, including type and duration of ventilation, use of permanent HVAC systems, types of filters and schedule for replacement of filters.
   7. Describe cleaning and dust control procedures.
C. Interior Finishes Installation Schedule: Identify each interior finish that either generates odors, moisture, or vapors or is susceptible to adsorption of odors and vapors, and indicate air handling zone, sequence of application, and curing times.
D. Photographs: Photographic evidence of compliance with requirements for LEED credits.
E. Duct and Terminal Unit Inspection Report.
F. Air Contaminant Test Plan: Identify:
   1. Testing agency qualifications.
   2. Locations and scheduling of air sampling.
   3. Test procedures, in detail.
   4. Test instruments and apparatus.
   5. Sampling methods.
G. Air Contaminant Test Reports: Show:
   1. Location where each sample was taken, and time.
   2. Test values for each air sample; average the values of each set of 3.
   3. HVAC operating conditions.
   4. Certification of test equipment calibration.
   5. Other conditions or discrepancies that might have influenced results.
H. Ventilation Effectiveness Test Plan: Identify:
   1. Testing agency qualifications.
   2. Description of test spaces, including locations of air sampling.
   3. Test procedures, in detail; state whether tracer gas decay or step-up will be used.
   4. Test instruments and apparatus; identify tracer gas to be used.
   5. Sampling methods.
I. Ventilation Effectiveness Test Reports: Show:
   1. Include preliminary tests of instruments and apparatus and of test spaces.
   2. Calculation of ventilation effectiveness, E.
   3. Location where each sample was taken, and time.
   4. Test values for each air sample.
   5. HVAC operating conditions.
   6. Other information specified in ASHRAE 129.
   7. Other conditions or discrepancies that might have influenced results.
J. LEED Credit EQ 3: Plans and documentation for construction IAQ. Comply with Section 01 35 15

1.06 QUALITY ASSURANCE
   A. Testing and Inspection Agency Qualifications: Independent testing agency having minimum of 5 years experience in performing the types of testing specified.

PART 2 PRODUCTS
2.01 MATERIALS
   A. Low VOC Materials: See other sections for specific requirements for materials with low VOC content.

PART 3 EXECUTION
3.01 CONSTRUCTION PROCEDURES
   A. Prevent the absorption of moisture and humidity by adsorptive materials by:
      1. Sequencing the delivery of such materials so that they are not present in the building until wet work is completed and dry.
      2. Delivery and storage of such materials in fully sealed moisture-impermeable packaging.
      3. Provide sufficient ventilation for drying within reasonable time frame.
   B. Begin construction ventilation when building is substantially enclosed.
   C. If extremely dusty or dirty work must be conducted inside the building, shut down HVAC systems for the duration; remove dust and dirt completely before restarting systems.
D. HVAC equipment and ductwork may NOT be used for ventilation during construction:
   1. Provide temporary ventilation equivalent to 1.5 air changes per hour, minimum.
   2. Exhaust directly to outside.
   3. Seal HVAC air inlets and outlets immediately after duct installation.

E. Do not store construction materials or waste in mechanical or electrical rooms.

F. Prior to use of return air ductwork without intake filters clean up and remove dust and debris
generated by construction activities.
   1. Inspect duct intakes, return air grilles, and terminal units for dust.
   2. Clean plenum spaces, including top sides of lay-in ceilings, outsides of ducts, tops of
      pipes and conduit.
   3. Clean tops of doors and frames.
   4. Clean mechanical and electrical rooms, including tops of pipes, ducts, and conduit,
      equipment, and supports.
   5. Clean return plenums of air handling units.
   6. Remove intake filters last, after cleaning is complete.

G. Do not perform dusty or dirty work after starting use of return air ducts without intake filters.

H. Use other relevant recommendations of SMACNA IAQ Guideline for Occupied Buildings Under
   Construction for avoiding unnecessary contamination due to construction procedures.

3.02 BUILDING FLUSH-OUT

A. Contractor's Option: Either full continuous flush-out OR satisfactory air contaminant testing is
   required, not both.

B. Perform building flush-out before occupancy.

C. Do not start flush-out until:
   1. All construction is complete.
   2. HVAC systems have been tested, adjusted, and balanced for proper operation.
   3. Inspection of inside of return air ducts and terminal units confirms that cleaning is not
      necessary.
   4. New HVAC filtration media have been installed.

D. Building Flush-Out: Operate all ventilation systems at normal flow rates with 100 percent
   outside air until a total air volume of 14,000 cubic feet per square foot of floor area has been
   supplied.
   1. Obtain Owner's concurrence that construction is complete enough before beginning
      flush-out.
   2. Maintain interior temperature of at least 60 degrees F and interior relative humidity no
      higher than 60 percent.
   3. If additional construction involving materials that produce particulates or any of the
      specified contaminants is conducted during flush-out, start flush-out over.
   4. If interior spaces must be occupied prior to completion of the flush-out, supply a minimum
      of 25 percent of the total air volume prior to occupancy, and:
         a. Begin ventilation at least three hours prior to daily occupancy.
         b. Continue ventilation during all occupied periods.
         c. Provide minimum outside air volume of 0.30 cfm per square foot or design minimum
            outside air rate, whichever is greater.

E. Install new HVAC filtration media after completion of flush-out and before occupancy or further
   testing.

3.03 AIR CONTAMINANT TESTING

A. Contractor's Option: Either full continuous flush-out OR satisfactory air contaminant testing is
   required, not both.

B. Perform air contaminant testing before occupancy.

C. Do not start air contaminant testing until:
1. All construction is complete, including interior finishes.
2. HVAC systems have been tested, adjusted, and balanced for proper operation.
3. New HVAC filtration media have been installed.


E. Analyze air samples and submit report.

F. If air samples show concentrations higher than those specified, ventilate with 100 percent outside air and retest at no cost to Owner, or conduct full building flush-out specified above.

3.04 VENTILATION EFFECTIVENESS TESTING

A. Perform ventilation effectiveness testing before occupancy.

B. Do not begin ventilation effectiveness testing until:
   1. HVAC testing, adjusting, and balancing has been satisfactorily completed.
   2. Building flush-out or air contaminant testing has been completed satisfactorily.
   3. New HVAC filtration media have been installed.

C. Test each air handler zone in accordance with ASHRAE 129.

D. If calculated air change effectiveness for a particular zone is less than 0.9 due to inadequate balancing of the system, adjust, and retest at no cost to Owner.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.
B. Re-use of existing products.
C. Transportation, handling, storage and protection.
D. Product option requirements.
E. Substitution limitations and procedures.
F. Procedures for Owner-supplied products.
G. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
B. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
C. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or reused from other projects are not considered new products.
D. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
E. Substitutions: Contractor proposed changes in products, materials, equipment, or methods of construction different from those required by the Contract Documents.
F. VOC: Volatile organic compound, carbon compounds that participate in atmospheric photochemical reactions and vaporize at normal room temperature. Measure as grams per liter, less water.
G. Bidding/ Negotiating Period: The period within the project schedule where the Contractor receives bids or pricing from subcontracts or prepares their own bid to establish a contract value with the Owner.
H. Award of Contract: The formal acceptance of the terms of the negotiation by the Contractor.
I. Notice to Proceed: A document that establishes the date work is authorized to commence. It may also include the number of calendar days or date of substantial completion.

1.03 SUBMITTALS

A. Submittal procedure for Product Data, Shop Drawings, Samples, and Certificates is specified in Section 01 33 00 - Submittal Procedure.
B. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
   1. Submit within 15 days after date of Notice to Proceed.
   2. For products specified only by reference standards, list applicable reference standards.
C. Indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
D. Request for Substitution: Submit approved form with supporting information to CM/GC. Comply with "Substitution Procedures" Article in this Section.
   1. Requests During Bidding/ Negotiating period: CSI Form 1.5C or current CSI Northwest Region Form.
2. Requests after Bidding/Negotiating period: CSI Form 13.1A.
3. Submit original request forms in quantity required distribution. Original must be signed by person authorized to certify the substitution request form. Architect may request proof of authorization.

1.04 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Construction deliveries shall be made at the project jobsite to the attention of the Contractor; not FS receiving.
B. Products and materials shall be protected from damage, weather, vandalism, etc. prior to installation. Replacement and replacement cost will be the responsibility of the Contractor.

1.06 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
   1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
   3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by the Contract Documents.
B. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.
C. Reused Products: Reused products include materials and equipment salvaged and refurbished as specified.
   1. Protect, repair and prepare for installation items indicated as "reinstall" or "salvage for reinstallation'.
   2. Replace items that are damaged beyond repair during demolition or construction.

2.02 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by the Contract Documents.
B. Provide commercial grade products as a minimum; residential grade products are unacceptable.
C. Do not use products having any of the following characteristics:
   1. Made using or containing CFC's or HCFC's.
   2. Made of wood from newly cut old growth timber.
D. Where all other criteria are met, Contractor shall give preference to products that:
   1. Are extracted, harvested, and/or manufactured within 500 miles of the project.
   2. Are made with rapidly renewable material.
   3. Contain more recycled material.
   4. Use sustainably harvested wood over non-sustainably harvested wood.
   5. Do not contain urea formaldehyde.
   6. Contain fewer VOCs.
   7. Are Green Label Plus carpet, cushion or adhesive.
   8. Have longer documented life span under normal use.
   9. Result in less construction waste.

E. Products with Rapidly Renewable Material Content:
   1. Definition: Materials made from plants that are typically harvested within 10 years or less after planting.
   2. Overall Project Requirement: Provide materials amounting to a minimum of 2.5 percent of the total value of all materials and products used on the project.
   3. Specific Product Categories: Provide renewable material content as specified elsewhere.
   4. Calculations: Where information about renewable material content is required to be submitted and an item is not made completely of rapidly renewable material, calculate content by dividing the renewable material content by weight by the total weight of the item.
   5. Submittals: State unit cost, renewable material content percentage, quantity installed, total material cost, and total renewable material value; attach evidence of contents from either manufacturer or an independent agency.

F. Products with Recycled Content:
   1. Overall Project Requirement: Provide products with recycled content such that the sum of post-consumer recycled content plus one-half of the post-industrial recycled content constitutes at least 10 percent of the total value of all products installed, except mechanical and electrical components.
      a. This provision is applicable to LEED Credit MR 4; show quantity and calculations on LEED report.
   2. Specific Product Categories: Provide recycled content as specified elsewhere.
   3. Calculations: Where information about recycled content is required to be submitted:
      a. Determine percentage of post-consumer and post-industrial content separately, using the guidelines contained in 16 CFR 260.7(e).
      b. Previously used, reused, refurbished, and salvaged products are not considered recycled.
      c. Wood fabricated from timber abandoned in transit to original mill is considered reused, not recycled.
      d. Determine percentage of recycled content of any item by dividing the weight of recycled content in the item by the total weight of all material in the item.
      e. Determine value of recycled content of each item separately, by multiplying the content percentage by the value of the item.
   4. Submittals: State unit cost, post-consumer and post-industrial content percentages, quantity installed, total material cost, and total recycled content value; attach evidence of contents from either manufacturer or an independent agency.

G. Certified Wood - Sustainably Harvested Wood:
   1. Definition: Wood-based materials include but are not limited to structural framing, dimension lumber, flooring, wood doors, finishes, and furnishings that are permanently installed in the project. Wood and wood-based products not permanently installed in the project are not included in the definition.
   2. Overall Project Requirement: Provide a minimum of 50 percent of all wood-based materials made of sustainably harvested wood.
      a. This provision is applicable to LEED Credit MR 6/7; show quantity on LEED report and submit certificates.
3. Specific Wood-Based Fabrications: Fabricate of sustainably harvested wood when so specified elsewhere.

4. Certification: Provide wood certified or labeled by an organization accredited by one of the following:

5. Submittals: State unit cost of each wood-based item, quantity installed, quantity certified as sustainably harvested, total wood-based material cost, and total sustainably harvested value; provide letter of certification signed by supplier of each item, indicating compliance with the specified requirements and identifying the certifying organization.
   a. Provide chain-of-custody documentation:
   b. Include the certifying organization's certification numbers for each certified product, itemized on a line-item basis.
   c. Attach copies of invoices bearing the certifying organization's certification numbers.

H. Urea-Formaldehyde Prohibition:
   1. Overall Project Requirement: Provide composite wood and agrifiber products having no added urea-formaldehyde resins. Laminating adhesives used to fabricate both on-site and shop-applied composite wood and agrifiber assemblies shall not contain urea formaldehyde resin.
      a. This provision is applicable to LEED Credit EQ 4.4; submit LEED Prohibited Content Installer Certification Forms.
      b. Require each installer to certify compliance and submit product data showing product content.
   2. Specific Product Categories: Comply with limitations specified elsewhere.

I. Adhesives and Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168, and Green Seal Standard for Commercial Adhesives GS-36.
   1. This provision is applicable to LEED Credit EQ 4.1.
      a. Require each installer to certify compliance and submit product data showing product content.
   2. Specific Product Categories: VOC in grams/Liter shall not exceed:
      a. Indoor Carpet Adhesive: 50.
      b. Carpet Pad Adhesive: 50.
      c. Wood Flooring Adhesive:100.
      d. Rubber Flooring Adhesive:60.
      e. Subfloor Adhesive:50.
      g. VCT and Asphalt Adhesive:50.
      h. Gypsum Board Adhesive:50.
      i. Resilient Base Adhesive:50.
      j. Multipurpose Construction Adhesive: 70.
      k. Structural Glazing Adhesive:100.
   3. Specialty Applications: VOC in grams/Liter shall not exceed:
      a. PVC Welding:510.
      b. CPVC Welding:490.
      c. ABS Welding:325.
      e. Adhesive Primer for Plastic:550.
      f. Contact Adhesive:80.
      g. Special Purpose Contact Adhesive:250.
      h. Structural Wood Member Adhesive:140
      j. Top and Trim Adhesive:250.
   4. Substrate Specific Applications: VOC in grams/Liter shall not exceed:
PRODUCT REQUIREMENTS

a. Metal to Metal: 30.
d. Wood: 30.
e. Fiberglass: 80.

5. Sealants: VOC in grams/Liter shall not exceed:
   b. Roof: 300.
   e. Other: 250.

6. Primers for Sealants: VOC in grams/Liter shall not exceed:
   c. Other: 750.

7. Aerosol Adhesives: Percent VOC by weight shall not exceed:
   a. General Purpose Mist Spray: 65%.
   b. General Purpose Web Spray: 55%.
   c. Special Purpose (all types): 70%.

J. Interior Paints and Coatings: Provide only products having lower volatile organic compound (VOC) content than required by Green Seal Standards GS-11 and GC-03, SCAQMB Rule 1113, in grams/Liter as follows:
   1. This provision is applicable to LEED Credit EQ 4.2.
      a. Require each installer to certify compliance and submit product data showing product content.
   2. VOC in grams/Liter shall not exceed the following for each product:
      b. Flat opaque products: 50.
      c. Anti-corrosive paint: 250.
      d. Floor coating: 100.
      e. Clear varnish: 350.
      g. Sealer: 250.
      h. Other sealers: 200.
      i. Stains: 250.
      j. Lacquer: Not allowed.
   3. Comply with other requirements of GS-11 (component limitations, scrubbability, hiding power, washability).

K. Carpet, Carpet Tile, Carpet Cushion and Adhesives: Provide only products having lower volatile organic compound (VOC) content than required by Carpet and Rug Institute Green Label Plus Testing Program Limits, Emission Factor Limit in mg/sq.m. x hour as follows:
   1. Total Carpet or Carpet Tile VOC: 0.50
      a. 4-Phenylcyclohexene: 0.05
      b. Formaldehyde: 0.05
      c. Styrene: 0.40
      d. Green Label Plus testing for Acetaldehyde, Benzene, Caprolactam, 2-Ethylhexanoic Acid, Formaldehyde, 1-Methyl-2-Pyrrolidinone, Naphthalene, Nonanal, Octanal, 4-Phenylcyclohexene, Styrene, Toluene, and Vinyl Acetate.
   2. Total Adhesive VOC: 10.00
      a. Formaldehyde: 0.05
      b. 2-Ethyl-1-Hexanol: 3.00
   3. Total Cushion VOC: 1.00
      a. 4-Phenylcyclohexene: 0.05
      b. Formaldehyde: 0.05
PRODUCT REQUIREMENTS

4. This provision is applicable to LEED Credit EQ 4.3. Require each installer to certify compliance and submit product data showing product content.

L. Provide interchangeable components of the same manufacture for components being replaced.

M. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Size terminal lugs to NFPA 70, include lugs for terminal box.

N. Cord and Plug: Provide minimum 6 foot cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

D. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.

E. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

   1. If no product available within specified category matches and complies with other specified requirements, comply with provisions in "Product Substitutions" Article for proposal of product.

F. Visual Selection Specification: Selection of products for color, pattern, density, or texture will be by Architect from Manufacturer's full range, unless indicated otherwise.

   1. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.

   2. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.04 MAINTENANCE MATERIALS

A. Furnish maintenance/overstock/extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Specific construction overstock requirements are stated in each section as applicable.

C. Overstock goods shall be from the same manufacturer, lot and/or run as the material installed.

D. Provide complete written inventory of overstock goods in Excel format indicating product type, model number, installed location(s), name of supplier, quantity supplied, and storage location. Inventory shall be confirmed prior to issuance of Substantial Completion.

E. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

A. Instructions to Bidders specify time restrictions for submitting requests for substitutions during the bidding period. Comply with requirements specified in this section.

B. Substitutions may be considered during construction when a product becomes unavailable through no fault of the Contractor.
C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
   1. Note any departures from the Contract Documents or changes in previously reviewed submittals which were not commented upon in the initial review of information.

D. A request for substitution constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   2. Will provide the same warranty for the substitution as for the specified product.
   3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension that may subsequently become apparent.
   5. Where "visual matching" is not possible, paragraph 2.3E.
   6. Will reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
   7. Will reimburse the Architect for changes to the building design, including engineering design, detailing and additional Construction Administration services as a result of the proposed substitution.

E. Conditions for Substitution after Bidding/ Negotiating Period: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
   1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
   2. Requested substitution does not require revisions to the Contract Documents.
   3. Requested substitution is consistent with the Contract Documents and will produce indicated results including warranty, maintenance service or source replacement of parts.
   4. Requested substitution will not adversely affect Contractor's Construction Schedule or the work of other trades.
   5. Requested substitution will not require changing specifications or affect the Owner's activities.
   6. Requested substitution has received necessary approvals of authorities having jurisdiction.
   7. Requested substitution is compatible with other portions of the Work.
   8. Requested substitution has been coordinated with other portions of the Work.
   9. The Contractor agrees to reschedule activities around the required redesign time needed without changing Substantial Completion date and reimburse Architect for changes to the building design, including design, detailing and additional Construction Administration services as a result of the proposed substitution.

F. Substitutions will not be considered when they are indicated or implied on Shop Drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
   1. Submit proposed substitution 14 days prior to submittal.

G. Substitution Submittal Procedure:
   1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
   2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
   4. Requests after Bidding/ Negotiating Period: Architect will notify Contractor in writing of decision to accept or reject request.
3.02 OWNER-FURNISHED PRODUCTS (CONTRACTOR INSTALLED)

A. Owner's Responsibilities:
   1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
   2. Arrange and pay for product delivery to site.
   3. On delivery, inspect products jointly with Contractor.
   4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
   5. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:
   1. Review Owner reviewed shop drawings, product data, and samples.
   2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
   3. Handle, store, install and finish products.
   4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

A. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

B. Transport and handle products in accordance with manufacturer's instructions.

C. Transport materials in a manner to prevent contamination of product and littering of surrounding areas.

D. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

E. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

F. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.

G. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

H. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
L. Installed products and materials shall be protected from damage, weather, vandalism, etc. prior to Final Completion. Replacement and replacement cost will be Contractor’s responsibility.

END OF SECTION
# SUBSTITUTION REQUEST

(After the Bidding/Negotiating Stage)

<table>
<thead>
<tr>
<th>Project:</th>
<th>Substitution Request Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>From:</th>
<th>To:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date:</th>
<th>A/E Project Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Re: Contract For: 

<table>
<thead>
<tr>
<th>Specification Title:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section:</th>
<th>Page:</th>
<th>Article/Paragraph:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Proposed Substitution:

<table>
<thead>
<tr>
<th>Manufacturer:</th>
<th>Address:</th>
<th>Phone:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trade Name:</th>
<th>Address:</th>
<th>Model No.:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Installer:</th>
<th>Address:</th>
<th>Phone:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

History: □ New product □ 1-4 years old □ 5-10 years old □ More than 10 years old

Differences between proposed substitution and specified product:

□ Point-by-point comparative data attached — REQUIRED BY A/E

## Reason for not providing specified item:

______________________________

Similar Installation:

<table>
<thead>
<tr>
<th>Project:</th>
<th>Architect:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address:</th>
<th>Owner:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date Installed:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

Proposed substitution affects other parts of Work: □ No □ Yes; explain ________________________________

Savings to Owner for accepting substitution: ________________________________ ($ ________).

Proposed substitution changes Contract Time: □ No □ Yes [Add] [Deduct] __________ days.

Supporting Data Attached: □ Drawings □ Product Data □ Samples □ Tests □ Reports □ ________________________________
The Undersigned certifies:

• Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
• Same warranty will be furnished for proposed substitution as for specified product.
• Same maintenance service and source of replacement parts, as applicable, is available.
• Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
• Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
• Proposed substitution does not affect dimensions and functional clearances.
• Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
• Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: ____________________________________________

Signed by: ______________________________________________

Firm: ___________________________________________________

Address: ________________________________________________

Telephone: _______________________________________________

Attachments: ______________________________________________


A/E’s REVIEW AND ACTION

☐ Substitution approved – Make submittals in accordance with Specifications Section 01 60 00 Product Requirements.
☐ Substitution approved as noted – Make submittals in accordance with Specification Section 01 60 00 Product Requirements.
☐ Substitution rejected – Use specified materials.
☐ Substitution Request received too late – Use specified materials.

Signed by: ____________________________ Date: ______________

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E ☐ ____________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.
B. Cutting and patching.
C. Laying out the work.
D. Cleaning and protection.
E. Starting of systems and equipment.
F. Demonstration and instruction of Owner personnel.
G. Closeout procedures, except payment procedures.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Cutting and Patching: If not shown in Documents, submitt an RFI in advance of cutting or alteration that affects:
   1. Structural integrity of any element of Project.
   2. Integrity of weather exposed or moisture resistant element.
   3. Efficiency, maintenance, or safety of any operational element.
   5. Work of Owner or separate Contractor.
C. Substantial Completion Documents: Statement that Project is substantially complete and list of incomplete items (Punch List).
   1. 1 copy.
   2. Other items listed under Substantial Completion in Part 3.
D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.03 QUALIFICATIONS

A. For survey work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of Surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate to be kept on file in Contractor's office.

1.04 PROJECT CONDITIONS

A. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
B. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
C. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property, as required by Authority Having Jurisdiction (AHJ).
D. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations, as required by Authority Having Jurisdiction (AHJ).
E. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
F. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.
G. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.
1.05 COORDINATION
   A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
   B. Notify affected utility companies and comply with their requirements.
   C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
   D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
   E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
   F. Coordinate completion and clean-up of work of separate sections.
   G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS
2.01 PATCHING MATERIALS
   A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
   B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
   C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
   B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
   C. Examine and verify specific conditions described in individual specification sections.
   D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
   E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
   F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION
   A. Clean substrate surfaces prior to applying next material or substance.
   B. Seal cracks or openings of substrate prior to applying next material or substance.
   C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.
3.03 LAYING OUT THE WORK
   A. Verify locations of survey control points prior to starting work.
   B. Promptly notify Architect of any discrepancies discovered.
   C. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
   D. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
   E. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
   F. Utilize recognized engineering survey practices.
   G. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
      1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
      2. Grid or axis for structures.
      3. Building foundation, column locations, ground floor elevations.
   H. Periodically verify layouts by same means.
   I. Maintain a complete and accurate log of control and survey work as it progresses.

3.04 GENERAL INSTALLATION REQUIREMENTS
   A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
   B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
   C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
   D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
   E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 CUTTING AND PATCHING
   A. Whenever possible, execute the work by methods that avoid cutting or patching.
   B. Perform whatever cutting and patching is necessary to:
      1. Complete the work.
      2. Fit products together to integrate with other work.
      3. Provide openings for penetration of mechanical, electrical, and other services.
      4. Match work that has been cut to adjacent work.
      5. Repair areas adjacent to cuts to required condition.
      6. Repair new work damaged by subsequent work.
      7. Remove samples of installed work for testing when requested.
      8. Remove and replace defective and non-conforming work.
   C. Execute cutting and patching including excavation and fill to complete the work, to uncover work in order to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing when requested, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit products together to integrate with other work.
   D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
   E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
   1. Do not overcut at corners of masonry, concrete, metals and similar rigid materials.

G. Restore work with new products in accordance with requirements of Contract Documents.

H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.

J. Patching:
   1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
   2. Match color, texture, and appearance.
   3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

K. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

L. Make neat transitions. Patch work to match adjacent work in texture and appearance. Where new work abuts or aligns with existing, perform a smooth and even transition.

3.06 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

E. Daily Cleaning Requirements:
   1. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.
   2. After cutting and boring, contractor is required to clean the space of all debris, water and concrete.
   3. Keep the premises free from accumulation of debris.
   4. Remove all debris, equipment, surplus materials and leave the premises in a neat and orderly condition at the completion of the work day.
   5. Clean all walks, streets, etc. affected by the work.

3.07 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
G. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

### 3.08 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.
B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
D. Verify that wiring and support components for equipment are complete and tested.
E. Execute start-up under supervision of applicable Contractor personnel and manufacturer’s representative in accordance with manufacturers’ instructions.
F. Submit a written report that equipment or system has been properly installed and is functioning correctly.

### 3.09 DEMONSTRATION AND INSTRUCTION

A. Demonstrate operation and maintenance of products to Owner’s personnel two weeks prior to date of Substantial Completion.
B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.
   1. Training & demonstration session of overview for all trades and response groups.
   2. In depth training and demonstration session for maintenance, technician, and service personnel. shall be to a maintenance technician, and/or service levels for all systems.
   3. Required hours will be listed in following standards.
C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
D. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of owner personnel.
E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

### 3.10 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

### 3.11 FINAL CLEANING

A. Execute final cleaning prior to Substantial Completion.
B. Use cleaning materials that are nonhazardous and will not damage the Work.
C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
F. Clean filters of operating equipment.
G. Clean debris from roofs, gutters, downspouts, and drainage systems.
H. Clean site; sweep paved areas, rake clean landscaped surfaces.
I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.
J. See also Divisions 31 and 32 for landscape restoration requirements.

K. Special cleaning for specific work may be noted in following sections of this document.

L. Comply with manufacturer's instructions for cleaning of all system components, equipment, and materials installed into the project.

M. Prior to the time the Contractor requests Substantial Completion Inspection:
1. Remove labels that are not required as permanent labels.
2. Clean exposed hard-surfaces finishes including glass, metals, stone, concrete, painted surfaces, plastics, tile, wood, special coatings, and similar surfaces, to a dirt free condition, free of dust, stains, films, and similar noticeable distracting substances.
4. Clean lighting fixtures and lamps of all dust and debris.
5. Remove crates, cartons, and other flammable waste materials or trash from work areas. Building(s) shall be turned over free of concealed garbage, trash, and rodent infestation. If any of the preceding is revealed, or odors from them occur, they shall be removed by the Contractor at Contractor's expense.
6. Restore all surrounding property to its original condition.
7. Elevator shafts, electric closets, pipe, and duct shafts, chases, furred spaces, and similar spaces which are generally unfurnished, shall be cleaned and left free from rubbish, loose plaster, mortar drippings, extraneous construction materials, dirt, and dust.
8. Rubbish and debris shall be lowered by way of chutes, hoists, or lowered in receptacles. Under no circumstances shall any rubbish or waste be dropped or thrown from one level to another within or outside the building(s).
9. No marking, soiling, or other defacing of finished surfaces. In the event that finished surfaces become defaced, all costs for cleaning and restoring such surfaces to their originally intended condition shall be the responsibility and cost of the Contractor.
10. Remove debris from and clean tops of all equipment, AHU, lights, etc. This includes mechanical rooms.

N. Prior to Contractor request of Final Acceptance Inspection:
1. Clean transparent materials, including mirrors and window or door glass, to a polished condition, removing substances that are noticeable as vision-obscuring materials.
2. Turn the work over in immaculate condition inside and outside including the premises.
3. Clean all work on the premises including walks, drives, curbs, paving, fences, grounds, and walls. Slick surfaces shall be left with a clear shine. Cleanup shall include removal of smudges, marks, stains, fingerprints, soil, dirt, paint, dust, lint, labels, discolorations, and other foreign materials.
4. Clean all finished surfaces on interior and exterior of project including floors, walls, ceilings, windows, glass, doors, fixtures, hardware, and equipment.
5. Clean and apply finish (including 'Anchor' wax) to all floors as recommended by the manufacturer.
6. Wash exterior glass using a window-cleaning contractor specializing in such work.
7. Remove temporary buildings and structures, fences, scaffolding, surplus materials, and rubbish of every kind from the site of the work. Repair these areas to be compatible with the surrounding finished conditions.
8. Clean tops of all equipment, AHU, lights, etc. This includes mechanical rooms.
9. Construction Waste Management, see Section 01 74 19.

3.12 CLOSEOUT PROCEDURES
A. Make submittals that are required by governing or other authorities.
1. Provide copies to Architect.

B. Notify Architect when work is considered ready for Substantial Completion.

C. Substantial Completion: Submit written statement that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's review.
1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
   a. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
   b. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   c. Include the following information at the top of each page: Project name; Date; Name of Architect; Name of Contractor; Page number.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction digital photographs, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
8. Complete startup testing of systems.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Certificate of Substantial Completion: On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
   1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Re-inspection is Extraordinary Contract Administration Service, Section 01 20 00.
   3. Results of completed inspection will form the basis of requirement for Final Completion.

E. Correct items of work listed in executed Certificates of Substantial Completion and comply with requirements for access to Owner-occupied areas.

F. Notify Architect when work is ready for Final Completion.
   1. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   2. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   3. Submit pest-control final inspection report and warranty.
   4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
   5. Submit demonstration and training videotapes.
G. Final Completion: On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will certify a final Certificate for Payment after inspection or will notify Contractor of work that must be completed or corrected before certificate will be issued.

H. Complete items of work determined by Architect’s final inspection.
   1. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Re-inspection is Extraordinary Contract Administration Service, Section 01 20 00.

END OF SECTION
PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Salvage and Recycling Requirements: Our goal is to salvage and recycle as much non-hazardous demolition and construction waste as possible including any demolition and/or construction waste.

C. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

D. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

E. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
   1. Aluminum and plastic beverage containers.
   2. Corrugated cardboard.
   3. Wood pallets.
   4. Clean dimensional wood: May be used as blocking or furring.
   5. Land clearing debris, including brush, branches, logs, and stumps: See Section 31 10 00 for use options.
   6. Concrete: May be crushed and used as riprap, aggregate, sub-base material, or fill.
   7. Bricks: May be used on project if whole, or crushed and used as landscape cover, sub-base material, or fill.
   8. Concrete masonry units: May be used on project if whole, or crushed and used as sub-base material or fill.
   9. Asphalt paving: May be recycled into paving for project.
   10. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
   11. Glass.
   12. Gypsum drywall and plaster.
   14. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (http://flooring.dupont.com) and Interface (www.interfaceinc.com) conduct reclamation programs.
   15. Asphalt roofing shingles.
   16. Paint.
   17. Plastic sheeting.
   18. Rigid foam insulation.
   19. Windows, doors, and door hardware.
   20. Plumbing fixtures.
   21. Mechanical and electrical equipment.
   22. Fluorescent lamps (light bulbs).
   23. Acoustical ceiling tile and panels.

F. Owner requires that 95 percent, by weight, of potential landfill trash/waste is diverted by recycling or salvage.

G. Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.

H. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.

I. The following sources may be useful in developing the Waste Management Plan:
2. State DEQ Commercial Waste Reduction Clearinghouse, at www.deq.state.or.us/wmc/cwrc.

J. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.
   5. Incineration, either on- or off-site.

K. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

A. Section 01 30 00 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. Section 01 50 00 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

C. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

D. Section 01 70 00 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

E. Section 31 10 00 - Site Clearing: Handling and disposal of land clearing debris.

1.03 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Material Recovery Facility: Waste sorting facility where commingled materials are accepted and recovered for recycling or salvage.

E. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

F. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

G. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

H. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

I. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

J. Return: To give back reusable items or unused products to vendors for credit.

K. Reuse: To reuse a construction waste material in some manner on the project site.

L. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

M. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
N. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

O. Toxic: Poisonous to humans either immediately or after a long period of exposure.

P. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

Q. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Recycling Plan: Prior to preparation of the Waste Management Plan, submit the recycling plan to the PM and Architect for approval.

C. Submit Waste Management Plan within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner; submit projection of all trash and waste that will require disposal and alternatives to landfilling.

D. Waste Management Plan: Include the following information:
   1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
   2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
   3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
   4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
   5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
   6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

E. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
   1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
   2. Submit Report on a form acceptable to Owner.
   3. Landfill Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
      c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
      e. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
   4. Recycled and Salvaged Materials: Include the following information for each:
      a. Identification of material, including those retrieved by installer for use on other projects.
      b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
f. Waste Reduction Calculations: Before request for Substantial Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste in weight generated by the Work.
g. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices. Include documentation for back-charge fees (if any) for improperly segregated waste.

5. Material Reused on Project: Include the following information for each:
   a. Identification of material and how it was used in the project.
   b. Amount, in tons or cubic yards.
   c. Include weight tickets as evidence of quantity.

6. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

F. LEED Credit MR 2: Plan and documentation for Construction Waste Management. Comply with Section 01 35 15.

G. Donation Record Keeping: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether or not the organization is tax exempt.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 WASTE MANAGEMENT PROCEDURES

A. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.

3.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Pre-bid meeting.
   2. Pre-construction meeting.
   3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. As a minimum, provide:
      a. Separate area for storage of materials to be reused on-site, such as wood cut-offs for blocking.
      b. Separate dumpsters for each category of recyclable.
      c. Recycling bins at worker lunch area.
   2. Label containers and areas with durable, weather-resistant signs. Use clear simple language. Use multiple languages spoken at Project Site.
3. Provide containers as required.
4. Provide adequate space for pick-up and delivery and convenience to subcontractors.
5. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
6. Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
7. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
8. Comply with project requirements for controlling dust and dirt, environmental protection, and noise control.

F. Alternative to Site Separation: Material Recovery Facility that provides specified documentation is acceptable in lieu of source-separated recycling facilities.

G. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

H. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

I. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

J. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Project Record Documents.
   B. Operation and Maintenance Manuals.

1.02 RELATED REQUIREMENTS
   A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
   B. Individual Product Sections: Specific requirements for operation and maintenance data.
   C. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS
   A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
   B. Operation and Maintenance Data:
      1. Submit one copy of preliminary manual before 75% of Work is complete. Include table of contents, outline contents of each section, and at least one typical finish section complete, and one equipment section complete. Architect will review preliminary and return one copy with comments.
      2. Applications for payment equal to and greater than 75% will not be certified until preliminary manual is submitted.
      3. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
      4. Submit 1 copy of completed documents 15 days prior to Substantial Completion. This copy will be reviewed and returned, with Architect comments. Revise content of all document sets as required prior to final submission.
      5. Submit two sets of revised final documents in final form within 10 days after request for final payment or request for final inspection, whichever is first.
   C. Warranties and Bonds:
      1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
      2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
      3. Items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS
   A. Maintain on site one set of the following record documents; record actual revisions to the Work:
      1. Drawings.
      2. Specifications.
      3. Addenda.
      4. Change Orders and other modifications to the Contract.
      5. Reviewed shop drawings, product data, and samples.
   B. Ensure entries are complete and accurate, enabling future reference by Owner.
   C. Store record documents separate from documents used for construction.
   D. Record information concurrent with construction progress.
1. Review current information with Architect prior to each Application for Payment. This is a condition for payment. See Section 01200

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish first floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Field changes of dimension and detail.
   4. Details not on original Contract drawings.

G. Commissioning Closeout Documentation: Provide commissioning closeout documentation and/or verification not included in the O&M manuals or as-built documentation.
   1. This information is intended to be a consolidation of documentation and verification for the project commissioning and closeout process.
   2. Include documentation of training of FS personnel regarding operation of particular systems. Such documentation shall include identification of parties receiving training and date(s) of training.

H. General Contractor As-Built document requirements / deliverables at project closeout: With all the following listed items, give particular attention to concealed products and portions of the work that are not clearly identified in the original submittal or cannot otherwise be readily discerned at a later date by direct observation.
   1. Original permit set of documents with sign off of inspections. Contractor should make copies of these sign offs for their records.
   2. 1 complete full-size, reproducible drawing sets on bond paper.
   3. 1 complete set of as-built specifications.
   4. 1 complete reproducible CD of as-built drawings and specifications in ‘pdf’ file format.
   5. 1 complete full-size reproducible drawing & specification set of Contractor's red-lines on bond paper.
   6. Complete digital set of all construction photographs by Contractor.

3.02 OPERATION AND MAINTENANCE DATA - GENERAL

A. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. For Each Product, Applied Material, and Finish:
   1. Product data, with catalog number, size, composition, and color and texture designations.
   2. Information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. For Each Item of Equipment and Each System:
   1. Description of unit or system, and component parts.
CLOSEOUT SUBMITTALS

2. Identify function, normal operating characteristics, and limiting conditions.
3. Include performance curves, with engineering data and tests.
4. Complete nomenclature and model number of replaceable parts.

B. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

C. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

D. Provide servicing and lubrication schedule, and list of lubricants required.

E. Include manufacturer's printed operation and maintenance instructions.

F. Include sequence of operation by controls manufacturer.

G. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

H. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLING OPERATION AND MAINTENANCE MANUALS

A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

B. Prepare data in the form of an instructional manual.

C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
   1. Multiple Volumes: Divide O & M information logically following CSI MasterFormat when more than one binder is necessary.
   2. Subtitle binders by Volume Number and CSI sub group title or CSI division title as appropriate.

D. Cover: Identify each binder with printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify Subtitle appropriate for subject matter of contents, Month and Year of Substantial Completion.

E. Table of Contents: Project name on each page; list products and systems included in Volume, indexed by CSI Section number.

F. Information Page: Project name; names, addresses, and telephone numbers of Architect, Consultants, and Contractor with name of responsible parties; date of substantial completion.

G. Index of Products: Table that can be sorted by word processor or spreadsheet; printed and digital formats; include product information under the following column headings:
   1. Product Name
   2. Manufacturer
   3. Model number
   4. O&M Volume Number
   5. Section Number

H. Arrange content by systems under Section numbers and sequence of Table of Contents of this Project Manual.

I. Provide tabbed dividers for each separate product or system, with Specification Section number and product name.
   1. Product Summary: On divider page or a separate first page indicate Specification Section number and title, product or system name, manufacturer, model, major components, supplier and installer information.

J. Text: Manufacturer's printed or typewritten information on 20 pound paper.
K. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

L. Elevator Operation and Maintenance Manual: Submit an additional copy of information for elevator in a separate manual, formatted similar to primary manual. This Manual will be kept in Elevator Machine Room.
   1. When Project includes more than one Elevator Machine Room, provide separate manuals with information for elevators served by that machine room.

M. Operation and Maintenance Manuals:
   1. 2 complete physical hard copies of ALL listed items.
   2. 1 complete reproducible CD of ALL listed items in ‘pdf’ file format.
   3. ALL part numbers of manufacturers and suppliers.
   4. Total quantities installed under the contract.
   5. Manufacturer and supplier names and addresses.
   6. Complete manufacturer’s serial number(s) or other identity symbol(s).
   7. Parts lists that clearly identify every part in the item of equipment with the proper manufacturer’s name, part nomenclature and number, local source, and list price.
   8. Draw-downs of all finish paint used.
   9. Recommended Spare Parts:
      a. Furnish a list of recommended spare parts for each equipment item that will be needed to support that item of equipment for a 12-month period.
      b. The quantities of spare parts recommended shall be based upon the quantity of like equipment items installed under the contract.
      c. Storage shelf life of part, in months, if the part has a limited life.
      d. Recommended quantity of part(s) to inventory and support the installed quantity of equipment in which the part appears for a period of 12 months.
      e. Name, address, and phone number of the nearest supplier for the part.
   10. Normal Operating Instructions: Provide sufficient information that will permit a journeyman mechanic to adjust, startup, operate, and shutdown the equipment. Special startup precautions and other action items required before the equipment is put into service must be noted.
   11. Emergency Operating Procedures: Detail description of the sequence of action to be taken in the event of a malfunction, either to permit a short period of continued operation or an emergency shutdown to prevent further damage to the unit and to the system.
   12. Preventative Maintenance: Detail information to cover routine and special inspection requirements, including field adjustments, inspections for wear, adjustment changes, packing wear, lubrication points, frequency and specific lubrication type required, cleaning of the unit, type of solvent to use, and other measures applicable.
   13. Calibration: Detailed data on what to calibrate, how to calibrate, when to calibrate, and procedures to enable checking the equipment for reliability; provide indications and data for test equipment, special tools and the location of test points. n. Scale and Corrosion Control: Detailed information for prevention and removal of scale and corrosion.
   14. Trouble Shooting Procedures: Detailed information and procedures for detecting and isolating malfunctions; provide detailed information concerning probable causes and applicable remedies.
   15. Removal and Installation Instructions: Detailed information concerning the logical sequence of steps required to remove and install the item including instructions for the use of special tools and equipment.
   16. Disassembly and Assembly Instructions: Detailed illustrations and text to show the logical procedure and provide the instructions necessary to disassemble and assemble the unit properly. The text shall include all checks and special precautions and list the use of special tools and equipment required to perform the assembly or disassembly.
   17. Repair Instructions: Detailed repair procedures to bring the equipment up to the required operating standard including instruction for examining equipment and parts for needed
repairs and adjustments, and tests or inspections required to determine whether old parts may be reused or must be replaced.

18. System Drawings: Detailed drawings, where applicable, that clearly show wiring diagrams, control diagrams, system schematics, pneumatic and fluid flow diagrams, etc., which pertain to the unit function. Drawings are required to show modifications to another manufacturer’s standard unit which is incorporated into the assembly or packaged unit.
   a. The Contractor shall provide diagrammatic drawings for each installed system, which shall show the placement of the system in relation to the building, and the physical location of each item or equipment installed within the system. Each installed item of equipment shown on the drawing will be identified by the equipment item model and/or serial/part number.

19. Special Tools and Test Equipment: Furnish a detailed list of the special tools and test equipment needed to perform repair and maintenance for each equipment item. The list shall contain the special tool and test equipment part number, size, quantity, price, manufacturer’s name and address, and local supplier’s name and address.

20. Warranties and Guarantees: Within each tabbed section of the O&M, include an executed copy of the specified warranty/guarantee covering the particular system, equipment item, or material.
   a. This is to include both the manufacturer’s warranty and the installing contractor’s guarantee for workmanship and system operation. This copy of the particular warranty/guarantee is in addition to the original signed copies that are to be bound together separately.
   b. Provide a separate binder containing all original project warranties and guarantees.

21. Field records on excavations, foundations, underground construction, wells, and similar work; if not already included in as-built drawings / documentation.

22. Accurate survey showing locations and elevations of underground lines, including invert elevations of drainage piping; if not already included in as-built drawings / documentation.

23. Surveys establishing lines and levels of buildings; if not already included in as-built drawings / documentation.

24. Load and/or performance testing.

25. Final inspection and deficiency corrections.

26. Prior to date of substantial completion the Architect and PM shall determine which (if any) samples or mock-ups are to be transmitted to the PM for record purposes.

27. With all the above listed items, give particular attention to concealed products and portions of the work that are not clearly identified in the original submittal or cannot otherwise be readily discerned at a later date by direct observation.

3.06 WARRANTIES AND BONDS MANUAL

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial completion is determined.

1. Always provide, at a minimum, the responsible Subcontractor’s, supplier's and manufacturer’s standard product warranty unless noted otherwise in the individual specification sections.

2. All listed manufacturers and all listed installers through the act of submitting a bid are confirming obligatory responsibility for providing an equal quantity and equal quality warranty to the design basis warranties listed, unless individual specification sections note otherwise.

3. Minimum warranty for all material and workmanship, building envelope and penetration components excluded per above noted ORS, for a minimum of 1-year after date of substantial completion OR for the extended period of time determined by manufacturer’s guarantee.

4. Extended warranties may be required for specific items as noted in the following document.
5. Correct immediately any failure caused by poor material or workmanship during warranty period; within 72 hours of notice.  
6. If the PM or FS personnel are required to proceed with repairs, the responsible party of the warranty will be billed for costs and damages when failing to comply.

B. Verify that documents are in proper form, contain full information, and are notarized.
C. Co-execute submittals when required.
D. Retain warranties and bonds until time specified for submittal.
E. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.
F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.
   1. Do not include “And Bonds” when Project does not include bonds.
G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

3.07 MAINTENANCE MATERIALS
A. Closeout delivery of any and all closeout and/or overstock items to the PM requires formal transmittals for project records; including O&M manuals, extra materials, custom finish knives, etc.
B. See Section 01 60 00 for additional requirements.

END OF SECTION
PART 1 GENERAL

1.01 SUMMARY

A. Commissioning is intended to achieve the following specific objectives; this section specifies the Contractor's responsibilities for commissioning:
   1. Verify that the work is installed in accordance with the Contract Documents and the manufacturer's recommendations and instructions, and that it receives adequate operational checkout prior to startup: Startup reports and Prefunctional Checklists executed by Contractor are utilized to achieve this.
   2. Verify and document that functional performance is in accordance with the Contract Documents: Functional Tests executed by Contractor and witnessed by the Commissioning Authority are utilized to achieve this.
   3. Verify that operation and maintenance manuals submitted to Owner are complete: Detailed operation and maintenance (O&M) data submittals by Contractor are utilized to achieve this.
   4. Verify that the Owner's operating personnel are adequately trained: Formal training conducted by Contractor is utilized to achieve this.

B. The Commissioning Authority directs and coordinates all commissioning activities; this section describes some but not all of the Commissioning Authority's responsibilities.

C. The Commissioning Authority is employed by Owner.

1.02 SCOPE OF COMMISSIONING

A. The following are to be commissioned:
   B. Plumbing Systems:
   C. HVAC System, including:
   D. Special Ventilation:
   E. Electrical Systems:
   F. Electronic Safety and Security:
   G. Communications:
   H. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
   I. Indoor Air Quality Procedures: The Commissioning Authority will coordinate; Contractor will execute; see Section 01 57 21.

1.03 RELATED REQUIREMENTS

A. Section 01 57 21 - Indoor Air Quality Controls: Precautions and procedures; smoking room testing; building flush-out.
B. Section 01 78 00 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures; except:
   1. Make all submittals specified in this section, and elsewhere where indicated for commissioning purposes, directly to the Commissioning Authority, unless they require review by Architect; in that case, submit to Architect first.
   2. Submit one copy to the Commissioning Authority, not to be returned.
   3. Make commissioning submittals on time schedule specified by Commissioning Authority.
   4. Submittals indicated as "Draft" are intended for the use of the Commissioning Authority in preparation of Prefunctional Checklists or Functional Test requirements; submit in editable electronic format, Microsoft Word 2003 preferred.
   5. As soon as possible after submittals made to Architect are approved, submit copy of approved submittal to the Commissioning Authority.
B. Manufacturers' Instructions: Submit copies of all manufacturer-provided instructions that are shipped with the equipment as soon as the equipment is delivered.

C. Product Data: If submittals to Architect do not include the following, submit copies as soon as possible:
   1. Manufacturer's product data, cut sheets, and shop drawings.
   2. Manufacturer's installation instructions.
   3. Startup, operating, and troubleshooting procedures.
   4. Fan and pump curves.
   5. Factory test reports.
   6. Warranty information, including details of Owner's responsibilities in regard to keeping warranties in force.

D. Startup Plans and Reports.
E. Completed Prefunctional Checklists.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
   1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F and resolution of plus/minus 0.1 degree F.
   2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
   3. Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.

C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

D. Dataloggers: Independent equipment and software for monitoring flows, currents, status, pressures, etc. of equipment.
   1. Dataloggers required to for Functional Tests will be provided by the Commissioning Authority and will not become the property of Owner.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN

A. Commissioning Authority has prepared the Commissioning Plan.
   1. Attend meetings called by the Commissioning Authority for purposes of completing the commissioning plan.
   2. Require attendance and participation of relevant subcontractors, installers, suppliers, and manufacturer representatives.

B. Contractor is responsible for compliance with the Commissioning Plan.

C. Commissioning Plan: The commissioning schedule, procedures, and coordination requirements for all parties in the commissioning process.

D. Commissioning Schedule:
   1. Submit anticipated dates of startup of each item of equipment and system to Commissioning Authority within 60 days after award of Contract.
   2. Re-submit anticipated startup dates monthly, but not less than 4 weeks prior to startup.
3. Prefunctional Checklists and Functional Tests are to be performed in sequence from components, to subsystems, to systems.
4. Provide sufficient notice to Commissioning Authority for delivery of relevant Checklists and Functional Test procedures, to avoid delay.

### 3.02 STARTUP PLANS AND REPORTS

A. **Startup Plans:** For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 8 weeks prior to startup.

B. **Startup Reports:** For each item of equipment and system for which the manufacturer provides a startup checklist (or startup plan or field checkout sheet), document compliance by submitting the completed startup checklist prior to startup, signed and dated by responsible entity.

C. Submit directly to the Commissioning Authority.

### 3.03 PREFUNCTIONAL CHECKLISTS

A. A Prefunctional Checklist is required to be filled out for each item of equipment or other assembly specified to be commissioned.

1. No sampling of identical or near-identical items is allowed.
2. These checklists do not replace manufacturers' recommended startup checklists, regardless of apparent redundancy.
3. Prefunctional Checklist forms will not be complete until after award of the contract; the following types of information will be gathered via the completed Checklist forms:
   - Certification by installing contractor that the unit is properly installed, started up, and operating and ready for Functional Testing.
   - Confirmation of receipt of each shop drawing and commissioning submittal specified, itemized by unit.
   - Manufacturer, model number, and relevant capacity information; list information "as specified," "as submitted," and "as installed."
   - Serial number of installed unit.
   - List of inspections to be conducted to document proper installation prior to startup and Functional Testing; these will be primarily static inspections and procedures; for equipment and systems may include normal manufacturer's start-up checklist items and minor testing.
   - Sensor and actuator calibration information.

4. Contractor is responsible for filling out Prefunctional Checklists, after completion of installation and before startup; witnessing by the Commissioning Authority is not required unless otherwise specified.

   1. Each line item without deficiency is to be witnessed, initialed, and dated by the actual witness; checklists are not complete until all line items are initialed and dated complete without deficiencies.
   2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing; re-submission of the Checklist is required upon completion of remaining items.
   3. Individual Checklists may contain line items that are the responsibility of more than one installer; Contractor shall assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.
   4. If any Checklist line item is not relevant, record reasons on the form.
   5. Contractor may independently perform startup inspections and/or tests, at his option.
   6. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.
   7. Submit completed Checklists to Commissioning Authority within two days of completion.

B. Commissioning Authority is responsible for furnishing the Prefunctional Checklists to Contractor.

   1. Initial Drafts: Contractor is responsible for initial draft of Prefunctional Checklist where so indicated in the Contract Documents.
2. Provide all additional information requested by Commissioning Authority to aid in preparation of checklists, such as shop drawing submittals, manufacturers’ startup checklists, and O&M data.
3. Commissioning Authority may add any relevant items deemed necessary regardless of whether they are explicitly mentioned in the Contract Documents or not.
4. When asked to review the proposed Checklists, do so in a timely manner.

D. Commissioning Authority Witnessing: Required for:
   1. Each piece of primary equipment, unless sampling of multiple similar units is allowed by the commissioning plan.
   2. A sampling of non-primary equipment, as allowed by the commissioning plan.

E. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.
   1. If difficulty in correction would delay progress, report deficiency to the Commissioning Authority immediately.

3.04 FUNCTIONAL TESTS

A. A Functional Test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.

B. Contractor is responsible for execution of required Functional Tests, after completion of Prefunctional Checklist and before closeout.

C. Commissioning Authority is responsible for witnessing and reporting results of Functional Tests, including preparation and completion of forms for that purpose.

D. Contractor is responsible for correction of deficiencies and re-testing at no extra cost to Owner; if a deficiency is not corrected and re-tested immediately, the Commissioning Authority will document the deficiency and the Contractor's stated intentions regarding correction.
   1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents or does not perform properly.
   2. When the deficiency has been corrected, the Contractor completes the form certifying that the item is ready to be re-tested and returns the form to the Commissioning Authority; the Commissioning Authority will reschedule the test and the Contractor shall re-test.
   3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
   4. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing re-testing.
   5. Contractor shall bear the cost of Owner and Commissioning Authority personnel time witnessing re-testing if the test failed due to failure to execute the relevant Prefunctional Checklist correctly; if the test failed for reasons that would not have been identified in the Prefunctional Checklist process, Contractor shall bear the cost of the second and subsequent re-tests.

E. Functional Test Procedures:
   1. Some test procedures are included in the Contract Documents; where Functional Test procedures are not included in the Contract Documents, test procedures will be determined by the Commissioning Authority with input by and coordination with Contractor.
   2. Examples of Functional Testing:
      a. Test the dynamic function and operation of equipment and systems (rather than just components) using manual (direct observation) or monitoring methods under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint).
b. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc.

c. Systems are run through all the HVAC control system’s sequences of operation and components are verified to be responding as the sequence’s state.

d. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Commissioning Authority is Functional Testing.

F. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions; performance of these tests remains the Contractor’s responsibility regardless of timing.

3.05 SENSOR AND ACTUATOR CALIBRATION

A. Calibrate all field-installed temperature, relative humidity, carbon monoxide, carbon dioxide, and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

B. Calibrate using the methods described below; alternate methods may be used, if approved by Owner beforehand. See PART 2 for test instrument requirements. Record methods used on the relevant Prefunctional Checklist or other suitable forms, documenting initial, intermediate and final results.

C. All Sensors:

1. Verify that sensor location is appropriate and away from potential causes of erratic operation.
2. Verify that sensors with shielded cable are grounded only at one end.
3. For sensor pairs that are used to determine a temperature or pressure difference, for temperature make sure they are reading within 0.2 degree F of each other, and for pressure, within tolerance equal to 2 percent of the reading, of each other.
4. Tolerances for critical applications may be tighter.

D. Sensors Without Transmitters - Standard Application:

1. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
2. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
3. If not, install offset, calibrate or replace sensor.

E. Sensors With Transmitters - Standard Application.

1. Disconnect sensor.
2. Connect a signal generator in place of sensor.
3. Connect ammeter in series between transmitter and building automation system control panel.
4. Using manufacturer’s resistance-temperature data, simulate minimum desired temperature.
5. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter.
6. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the building automation system.
7. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction.
8. Reconnect sensor.
9. Make a reading with a calibrated test instrument within 6 inches of the site sensor.
10. Verify that the sensor reading, via the permanent thermostat, gage or building automation system, is within the tolerances in the table below of the instrument-measured value.
11. If not, replace sensor and repeat.
12. For pressure sensors, perform a similar process with a suitable signal generator.

F. Sensor Tolerances for Standard Applications: Plus/minus the following maximums:
1. Watthour, Voltage, Amperage: 1 percent of design.
2. Pressure, Air, Water, Gas: 3 percent of design.
3. Air Temperatures (Outside Air, Space Air, Duct Air): 0.4 degrees F.
4. Relative Humidity: 4 percent of design.
5. Barometric Pressure: 0.1 inch of Hg.
6. Barometric Pressure: 0.1 inch of Hg.
7. Flow Rate, Air: 10 percent of design.
8. Flow Rate, Water: 4 percent of design.
9. AHU Wet Bulb and Dew Point: 2.0 degrees F.

G. Critical Applications: For some applications more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.

H. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper to open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

I. Isolation Valve or System Valve Leak Check: For valves not associated with coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

3.06 TEST PROCEDURES - GENERAL

A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.

C. Sampling: Where Functional Testing of fewer than the total number of multiple identical or near-identical items is explicitly permitted, perform sampling as follows:
   1. Identical Units: Defined as units with same application and sequence of operation; only minor size or capacity difference.
   2. Sampling is not allowed for:
       a. Major equipment.
       b. Life-safety-critical equipment.
       c. Prefunctional Checklist execution.
   3. XX = the percent of the group of identical equipment to be included in each sample; defined for specific type of equipment.
   4. YY = the percent of the sample that if failed will require another sample to be tested; defined for specific type of equipment.
   5. Randomly test at least XX percent of each group of identical equipment, but not less than three units. This constitutes the "first sample."
   6. If YY percent of the units in the first sample fail, test another XX percent of the remaining identical units.
   7. If YY percent of the units in the second sample fail, test all remaining identical units.
   8. If frequent failures occur, resulting in more troubleshooting than testing, the Commissioning Authority may stop the testing and require Contractor to perform and document a checkout of the remaining units prior to continuing testing.
D. Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the “observation”).

E. Simulating Conditions: Artificially create the necessary condition for the purpose of testing the response of a system; for example apply hot air to a space sensor using a hair dryer to see the response in a VAV box.

F. Simulating Signals: Disconnect the sensor and use a signal generator to send an amperage, resistance or pressure to the transducer and control system to simulate the sensor value.

G. Over-Writing Values: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation.

H. Indirect Indicators: Remote indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed, are considered indirect indicators.

I. Monitoring: Record parameters (flow, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of the relevant control systems; where monitoring of specific points is called for in Functional Test Procedures:
   1. All points that are monitored by the relevant control system shall be trended by Contractor; at the Commissioning Authority’s request, Contractor shall trend up to 20 percent more points than specified at no extra charge.
   2. Other points will be monitored by the Commissioning Authority using dataloggers.
   3. At the option of the Commissioning Authority, some control system monitoring may be replaced with datalogger monitoring.
   4. Provide hard copies of monitored data in columnar format with time down left column and at least 5 columns of point values on same page.
   5. Graphical output is desirable and is required for all output if the system can produce it.
   6. Monitoring may be used to augment manual testing.

3.07 OPERATION AND MAINTENANCE MANUALS

A. See Section 01 78 00 for additional requirements.

B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.

C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Selective demolition of built site elements.
B. Selective demolition of building elements for alteration purposes, excluding removal of hazardous materials and toxic substances.
C. Selective salvage of building elements.
D. Abandonment and removal of existing utilities and utility structures.
E. Concrete cutting and boring.

1.02 REFERENCE STANDARDS

1.03 DEFINITIONS
A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
B. Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.04 MATERIALS OWNERSHIP
A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during selective demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Site Plan: Showing:
   1. Vegetation to be protected.
   2. Areas for temporary construction and field offices.
   3. Areas for temporary and permanent placement of removed materials.
C. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
   1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.
   2. Identify demolition firm and submit qualifications.
   3. Include a summary of safety procedures.
D. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 3: Salvaged, refurbished or reused materials; product cost data.
E. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.06 QUALITY ASSURANCE
A. Demolition Firm Qualifications: Company specializing in the type of work required.
1. Minimum of 8 years of documented experience.

1.07 PROJECT CONDITIONS
A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
B. Comply with other requirements specified in Section 01 30 00 and 01 70 00.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION
3.01 SCOPE
A. Remove paving and curbs as required to accomplish new work.
B. Within area of new construction, remove foundation walls and footings to a minimum of 2 feet below finished grade.
C. Outside area of new construction, remove foundation walls and footings to a minimum of 2 feet below finished grade.
D. Remove concrete slabs on grade within construction limits indicated on drawings.
E. Saw cut and core concrete where indicated or as required to gain access to utilities, or provide utility tie-ins and new pathways and other access ways.
F. Remove other items indicated, for salvage, relocation, and recycling.
   1. Items to be salvaged are included on a list following this section.
G. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as specified in Section 31 22 00.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS
A. Comply with other requirements specified in Section 01 70 00 and 01 74 19.
B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Comply with applicable requirements of NFPA 241.
   3. Use of explosives is not permitted.
   4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   5. Provide, erect, and maintain temporary barriers and security devices.
   6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
   7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   8. Do not close or obstruct roadways or sidewalks without permit.
   9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
   10. Obtain written permission from FS when demolition equipment will will need to traverse, infringe upon or limit access to portions of the building under use.
C. Do not begin removal until receipt of notification to proceed from Owner.
D. Do not begin removal until built elements to be salvaged or relocated have been removed.
E. Do not begin removal until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.
F. Protect existing structures and other elements that are not to be removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.
G. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of facility or public waterways or storm sewers, or other pollution.

H. If hazardous materials are discovered during removal operations, stop work and notify Architect, PM and FS/Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury. See also Section 02 83 00 - Lead Control Procedures.

I. Perform demolition in a manner that maximizes salvage and recycling of materials.
   1. Comply with requirements of Section 01 74 19 - Construction Waste Management and Disposal.
   2. Dismantle existing construction and separate materials.
   3. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

J. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.

E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.

F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as shown.
   2. Report discrepancies to Architect before disturbing existing installation.
   3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Separate areas in which demolition is being conducted from other areas that are still occupied.
   1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 in locations indicated on drawings.

C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

D. Remove existing work as indicated and as required to accomplish new work.
   1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
   2. Remove items indicated on drawings.

E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
3. Verify that abandoned services serve only abandoned facilities before removal.
4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.

F. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.
   4. Patch as specified for patching new work.

3.05 DEBRIS AND WASTE REMOVAL
   A. Remove debris, junk, and trash from site.
   B. Remove from site all materials not to be reused on site; comply with requirements of Section 01 74 19 - Waste Management.
   C. Leave site in clean condition, ready for subsequent work.
   D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION
PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. The provisions and intent of the contract, including the General Conditions, Special Conditions and General Requirements apply to this work as if specified in this Section. Work related to this Section is described in:

B. Section 01 35 03 - Regulated Materials Abatement Submittals
C. Section 02 82 13 - Asbestos Abatement
D. Section 02 84 16 - Universal Wastes Removal and Disposal

1.02 DESCRIPTION OF WORK

A. General work items include, but are not necessarily limited to:

1. Building materials sampled contain detectable concentrations of lead above and below the United States Department of Housing and Urban Development (HUD) definition of lead based paint (1.0 milligrams per square centimeter).
2. There is a potential for exposure to lead and lead dust during asbestos abatement, demolition and new construction work. The Contractor is responsible for monitoring work activities and determining when work involves hazardous materials and conditions that require conformance with specified regulatory requirements. Applicable regulations regarding exposure to lead (Oregon Administrative Rules, Oregon Occupational Safety and Health Division, Subpart D, 1926.62) apply to this project.
3. The project requires welding and cutting of existing structural steel. Due to the elevated risk for worker exposure, the contractor shall outline specific procedures for emissions control when performing these activities on existing structural steel.

1.03 CODES AND REGULATIONS

A. Due to the potential health and environmental hazards associated with the work at this site as described in this section, the work shall be performed in compliance with the applicable provisions of the Washington Industrial Safety and Health Act, and the Washington State Hazardous Waste Management Act, as well as other applicable federal, state, and local codes and regulations governing hazardous materials and hazardous waste. The Contractor is fully responsible for planning and executing all the work under this Contract in a manner that meets or exceeds the requirements of the OAR 1926.62 for protecting the health and safety of employees, the public, and for protecting the environment.

B. The following regulations of the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), the U.S. Environmental Protection Agency (EPA) and applicable requirements of the State of Washington are pertinent to this work. Other applicable regulations not specifically identified herein also apply.

1. United States Department of Labor, Occupational and Health Administration (OSHA):
   a. 29 CFR 1910 Occupational Safety and Health Standards
   b. 29 CFR 1910.134 Respiratory Protection
   c. 29 CFR 1910.1025 Lead
   d. 29 CFR 1910.1200 Hazard Communication
   e. 29 CFR 1910 Safety and Health Regulations for Construction
   f. 29 CFR 1926.55 Gases, Vapors, Fumes, Dusts, and Mists
   g. 29 CFR 1926.57 Ventilation
   h. 29 CFR 1926.62 Lead Exposure in Construction; Interim Rule (with appendices A, B, C and subpart D)

2. United States Environmental Protection Agency:
   a. 40 CFR 148 Hazardous Waste Injection Restrictions
   c. 40 CFR 261 Identification and Listing of Hazardous Waste
   d. 40 CFR 262 Standards Applicable to Generators of Hazardous Waste
   e. 40 CFR 263 Standards Applicable to Transporters of Hazardous Waste
f. 40 CFR 264 Standards for Owners and Operators of Hazardous Waste, Treatment, Storage, and Disposal Facilities

g. 40 CFR 265 Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

h. 40 CFR 268 Land Disposal Restrictions

i. 40 CFR 745 Lead; Requirements for Lead-based Paint Activities

j. 49 CFR 172 Hazardous Materials Tables and Hazardous Materials Communications Regulations

k. 49 CFR 178 Specifications for Packaging


4. National Institute for Occupational Safety and Health (OSHA):
   a. NIOSH OSHA Booklet 3142 Lead in Construction

5. State Requirements: Oregon Requirements, and/or DEQ rules which govern lead paint work or hauling and disposal include but are not limited to:
   a. OAR Subpart D, 1926.62
   c. OAR Department of Human services, Public Health Division 333-069

1.04 DEFINITIONS

A. Whenever the terms below occur in this Contract Document, they will have the meanings which follow:

1. Action Level: Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period. As used in this section, "30 micrograms per cubic meter of air" refers to the action level.

2. Air Monitoring: The process of measuring the concentration of lead in a specific volume of air in a stated period of time. Air samples shall be collected and analyzed in accordance with the methods specified by the National Institute for Occupational Safety and Health (NIOSH Method 7105) and as required by OAR 1926.62.

3. Area Monitoring: Sampling of lead concentrations within the lead control area, inside the physical boundaries that are representative of the airborne lead concentrations that may reach the breathing zone of personnel potentially exposed to lead.

4. Eight-Hour Time Weighted Average (TWA): Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.

5. Lead: Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

6. Lead Permissible Exposure Limit (PEL): Fifty micrograms per cubic meter of air as an 8-hour time weighted average.

7. Personal Monitoring: Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with OAR 1926.62. Samples shall be Consultant of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.

8. Industrial Hygienist: The Industrial Hygienist shall be at least one of the following:
   a. Certified by the American Board of Industrial Hygiene and have prior experience in the health and safety aspects of a lead hazard control work project.
   b. A professional engineer or certified safety professional with a minimum of three (3) years prior experience in industrial hygiene relating to lead hazard control work.

1.05 QUALITY ASSURANCE

A. The Contractor shall submit a work plan (pursuant to Paragraph 1.06 A of this Section) if work, other than heavy equipment general building demolition, will impact lead containing materials or if there is a potential for occupational exposure to lead above the action limit. The work plan will demonstrate that abatement, demolition, recycling and disposal of lead-coated and lead containing building materials will be performed in a manner consistent with pertinent federal,
state, and local regulation and this specification. The work plan will be submitted to the owner for review prior to the start of any lead related work.

B. The Owner or the Owner’s Consultant will perform periodic observation of the site work to ensure that it is being performed in a manner consistent with the Contractor’s reviewed work plan and this specification.

1.06 SUBMITTALS
   A. Contractors shall provide complete submittals as per Section 01300 and 01315 for review by the Owner’s representative.

PART 2 PRODUCTS

2.01 EQUIPMENT AND SUPPLIES
   A. Provide a list and description of equipment and supplies necessary to support the work as described in the work plan. Equipment and supplies may include but are not limited to:
      1. Chemicals to be used on-site including dust suppressants/wetting agents, fuels/lubricants, cleaning degreasing, and/or welding/cutting supplies;
      2. Enclosure equipment (for dust control);
      3. Fencing, barriers and signs;
      4. Demolition equipment;
      5. Materials and debris hauling/moving equipment;
      6. Material storage containers and supplies;
      7. Decontamination equipment and supplies;
      8. Protective clothing and respirators;
      9. Labels, manifests and other shipping documentation;
      10. Release prevention equipment;
      11. Field documentation logs/supplies; and,
      12. Protective clothing, respirators, equipment and supplies necessary to support the work.

PART 3 EXECUTION

3.01 WORK AREA PREPARATION
   A. Perform the following preliminary steps to prepare the Work Areas prior to work impacting lead or lead-coated building materials:
      1. Establish a Control Area that includes a perimeter sufficient to perform the work around each building or area that contains lead or lead-coated building materials. The control area shall also consist of the pathway for transport of any lead-contaminated material to a stockpile or storage receptacle, if lead-containing debris is not immediately transported from the site. Provide and display caution signs, in clearly visible areas, at entrances indicating that hazardous material work is being conducted and that unauthorized persons should not enter. Signs shall be comply with OAR 1926.62 regulations.
      2. Emergency Procedures: Establish and post written emergency procedures within each Work Area, including emergency contact names and contact phone numbers, plans for medical emergencies, temporary loss of electrical power or water, and procedures for an emergency. Contractor is responsible for establishing and posting contingency procedures to all workers on site.
      3. Health and Safety Briefing: Conduct a health and safety briefing prior to the start of work and weekly to discuss the health and safety plan, hazardous materials, hazardous work and other related items per the specified health and safety plan. More frequent briefings should be performed as required by project activities or changes in the work.
      4. Log-in Sheet: Restrict access to work sites by maintaining a daily log of personnel entering Work Areas; including workers and other authorized personnel and their start/stop times.
      5. Decontamination Unit: Prepare the decontamination unit for use at all entrances and exits from the Work Area as described in the approved work plan.
3.02 WORK PROCEDURE

A. General Procedures: Perform all work and comply with the safety and health provisions in the site specific Health and Safety Plan. The work includes all measures necessary to adequately protect workers, authorized personnel, and the public from lead exposures during abatement and demolition activities.

B. Coordination of Work of all Trades: Coordinate the work of all trades to ensure that work is performed in accordance with the applicable regulations and that the control limits are maintained at all times both inside and outside the control area.

C. Access to Work Area: Access to work areas shall be through decontamination areas. Only the Contractor, subcontractors, authorized Owner personnel, project consultants, and regulatory personnel shall have access to the work area.

D. Means of Egress: Establish and maintain emergency and fire exits from the work area.

E. Prevent dust generation at all times to the maximum extent practicable. Provide hand wash stations at appropriate and approved locations for the duration of demolition.

F. The use of water shall be restricted to the smallest quantity necessary to minimize dust and to avoid the potential of contaminant migration through run-off or ponding. In no case shall liquids generated during building demolition come into contact with uncontaminated soils, storm drains, surfaces or conduits which may constitute a release to the environment.

G. Demolition Procedures: Perform general demolition or demolition required for hazardous material abatement in areas of lead-containing paints in accordance with approved Health & Safety Plans. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead-containing paint is impacted or when building components are demolished. The procedures employed by the Contractor shall not create the potential for contaminating surrounding areas or materials with lead-containing coatings or dust. Dust generation shall be kept to a minimum. Dry scraping, dry sanding, or dry grinding on lead-containing paints or lead contaminated surfaces will not be permitted without a full enclosure.

H. All lead-coated demolition debris shall be handled, stored and disposed of as to meet applicable federal, state and local requirements.

I. Personnel and equipment decontamination shall occur whenever people or equipment leave the work site as described in the approved work plan. Decontamination waste shall be packaged, stored, labeled and disposed of according to all applicable requirements at the cost of the Contractor. All contaminated equipment, tools or materials that cannot be decontaminated shall be stored and disposed of by the Contractor in accordance with all federal, state and local regulations.

J. Grossly inadequate health, safety or environmental precautions on the part of the Contractor or the belief that the Contractor's personnel, the general public or the environment are or may be exposed to an immediate hazard, may be cause for the Owner to suspend the Contractor's site work and ask the Contractor's personnel to evacuate the hazard area. The Contractor shall not be compensated for such delays. The contractor is responsible for costs identified by the Owner as a consequence of the contractor's actions.

K. The Owner or the Owner's Consultant may inspect the Contractor's operations and work areas daily for job site cleanliness and conformance with the specifications. The Contractor shall locate any fuels, solvents or lubricants in a common area in a manner that will prevent releases to the environment. Any hazardous materials shall be appropriately labeled with the generic name of the contents and the Contractor's name.

1. Waste Sampling: Contractor will be required to collect representative samples of demolition debris for analysis as required under DEQ Regulations, to determine appropriate disposal methods. Select materials that were tested and determined to have lead in the coating for sampling and submittal to an approved laboratory for Toxicity Characteristic Leachate Procedure (TCLP) testing.
3.03 SITE QUALITY CONTROL AND MONITORING

A. Site Inspection: While performing the work, the Contractor may be subject to on site inspection by Oregon OSHA, EPA/Ecology inspectors and/or local building or health officials. If found to be in violation of pertinent regulations, the Contractor shall cease all work immediately until the violation is resolved. Standby time required to resolve the violation shall be at the Contractor's expense. Complete sets of equipment (such as respirators and disposable clothing) that may be required for entry to the control area shall be made available at all times by the Contractor to the Owner and/or agency inspectors for inspection of the control area. Such requests will only be made during working hours.

B. Quality Assurance
   1. Restrict the spread of dust and debris from being distributed over the work area.
   2. Area air quality monitoring and personnel monitoring shall be conducted throughout the work as appropriate.
   3. Air Monitoring: Monitoring of airborne concentrations of lead shall be in accordance with OAR 1926.62, and as specified herein. Air monitoring, testing, and reporting shall be performed in accordance with an Air Monitoring Plan prepared and signed by the Contractor's Industrial Hygienist. The plan shall include personal monitoring in accordance with regulatory requirements and area monitoring outside the lead control area.
      a. Submit results of air monitoring samples within 24 hours after the air samples were taken.
      b. Notify the Owner immediately of the corrective action taken if the exposure to lead is at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
      c. If the area air monitoring results are above the action level of 30 micrograms, the Owner shall have the option of stopping all work until the work procedures and lead hazard controls are revised to the Owner's satisfaction.

3.04 CLEAN-UP, TESTING AND DISPOSAL

A. Housekeeping: Housekeeping and clean-up procedures are essential tasks for contamination control. Maintain all surfaces throughout the area free of contaminated debris to the maximum extent practical. Restrict debris from being distributed over the general area. In all possible instances workers shall clean-up their own areas. Equip personnel engaged in cleaning up scrap and demolition debris with necessary respiratory equipment and protective clothing.

B. Cleanup: Maintain surfaces of the lead control area as free of accumulation of paint chips and dust as practicable. Restrict the spread of dust and debris; keep waste from being distributed over the work area. The use of compressed air to clean up the area is strictly prohibited. At the end of each shift, clean the area of visible lead paint contamination by vacuuming with a HEPA-filtered vacuum cleaner, wet mopping the area, or cleanup by other appropriate means.

C. Testing of Demolition Debris: The Contractor will be required to collect representative sample(s) of the actual demolition debris stream for Toxicity Characteristic Leaching Procedure (TCLP) analysis as required under DEQ Regulations. The Owner's Consultant reserves the right to review sampling procedures and analytical data before disposal of demolition waste.

D. Disposal of Lead Demolition Waste: If any lead dangerous waste is identified the following requirements shall be met for the disposal of lead dangerous waste:
   1. Collect lead dangerous waste, scrap, debris, bags, containers, equipment, and lead contaminated clothing that may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1910.1025.
3. The Transporter and Disposal Facility must each have an EPA identification number. The Contractor shall submit the name, address, and EPA Identification Number of the Transporter and Disposal Site to the Owner prior to the disposal of hazardous waste.

E. Disposal Documentation: Disposal documentation is required for all waste streams. At a minimum, provide a disposal receipt or manifest for all non-dangerous waste streams. For lead dangerous waste, if any is generated, submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD), or recycling facility is approved for lead dangerous waste disposal or recycling by the EPA and state or local regulatory agencies. Submit one (1) copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262. Final payment for the project shall not be made until all disposal documentation has been submitted and accepted by the Owner.

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for lead handling, waste disposal, and/or training will be made. The cost shall be considered incidental to and included in the Lump Sum price of the project.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following:
   1. Footings.
   2. Foundation walls.
   3. Slabs-on-grade.
   4. Suspended slabs.
   5. Concrete toppings.
   7. Building walls.
   8. Acoustical isolation floating slabs.
   9. Architectural Concrete Mock-ups for the following
      a. Retaining walls.
      b. Slabs.
      c. Interior ramp.
      d. Cast concrete against existing walls.
      e. Cast concrete in Hearth Area

B. This Section specifies architectural cast-in-place concrete for locations indicated, and all materials, procedures, and requirements specified in Section 03 30 00 Cast-in-Place Concrete shall fully apply to cast-in-place architectural concrete, except as otherwise specified.

1.02 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following, subject to compliance with requirements:
   1. Blended hydraulic cement.
   2. Fly ash and other pozzolans.
   3. Ground granulated blast-furnace slag.
   4. Silica fume.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at Project site.
   2. Include substantiating test data to show compliance with ACI 318 Chapter 5.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. The steel reinforcement detailer shall generate all shop drawing bending and installation details from the structural and architectural drawings and specifications. The use of reproductions or photocopies of the contract drawings shall not be permitted.
   1. Provide details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include special reinforcement required for openings through concrete structures.
   2. Shop drawing re-submittals shall clearly identify all revisions to previous submittals.
      a. Heavy ink clouded outlines (revision clouds) shall be drawn around revised areas of individual sheets.
      b. Architect/Engineer will not review information outside of revision clouds on resubmitted drawings.

D. Formwork Shop Drawings: Prepared by or under the supervision of a structural engineer licensed in the State of Oregon detailing fabrication, assembly, and support of formwork.
1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
2. Provide form tie layout showing aesthetically appropriate evenly spaced ties horizontally and vertically.

E. Waterstop Shop Drawings: PDF format showing locations and types per manufacturer's recommendations.
F. Samples: For waterstops and vapor retarder.
G. Welding certificates.
H. Qualification Data: For Installer, manufacturer, and testing agency.
   1. Qualification Data: For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
I. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Fiber reinforcement.
   6. Waterstops.
   7. Curing compounds.
   8. Floor and slab treatments.
   10. Adhesives.
   11. Vapor barriers.
   12. Semirigid joint filler.

J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.
K. Minutes of preinstallation conference.
L. Construction Joint Layout: Indicate proposed construction joints required to construct the structure. Location of construction joints is subject to approval by the Engineer.
M. Vapor barrier manufacturer's technical representative reports.

1.04 QUALITY ASSURANCE
A. Perform work of this section in accordance with ACI 301, ACI 117 and ACI 318.
B. Follow recommendations of ACI 305R when concreting during hot weather.
C. Follow recommendations of ACI 306R when concreting during cold weather.
D. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and supervisor who is an ACI-certified Concrete Flatwork Technician.
E. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM 94/C94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA’s “Certification of Ready Mixed Concrete Production Facilities.
F. For slabs-on-grade required to include an under-slab vapor barrier, provide a vapor barrier from a firm experienced in manufacturing vapor barriers and conforming to the requirements specified herein. Do not proceed with placement unless manufacturer's technical representative is present for vapor barrier installation and for every day of concrete slab placement.
G. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade 1. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.

H. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant located within a 500 mile radius, obtain aggregate from one source, and obtain approved admixtures through one source.

I. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

J. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 01 30 00 - Administrative Requirements.
   1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor’s superintendent.
      b. Independent testing agency responsible for concrete design mixes.
      c. Ready mix concrete manufacturer.
      d. Concrete subcontractor.
      e. Steel reinforcement subcontractor when applicable.
      f. Under-slab vapor barrier
g. Under-slab vapor barrier manufacturer’s technical representative, for slabs on grade.
   2. Review procedures and special conditions and details for field quality control of vapor barrier placement.
   3. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

K. Manufacturer's Technical Representative:
   1. Visit site not less than three times, and more if required to review vapor barrier placement and installation procedures and concrete placement over vapor barrier.
      a. Pre-installation meeting.
      b. Duration of membrane installation for observation of completed membrane installation.
      c. After installation of reinforcing, when applicable, and during placement of concrete
   2. Document site visits in writing with copy to Architect.

L. Cast-In-Place Architectural Concrete:
   1. Installer Qualifications: A qualified contractor who has specialized in installing cast-in-place architectural concrete similar in material, design, and extent to that indicated for this Project, and capable of casting in place architectural concrete with finish as exists at Wieden and Kennedy, Portland, as an example of concrete finish expectation for this Project.
   2. Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment to achieve indicated quality expectations.
for Tolerances for Concrete Construction and Materials," unless more stringent provisions are indicated.

4. Mockups (Sample Panels): Before casting architectural concrete, produce a minimum of three (3) sets of full-scale sample panels, cast vertically, approximately 48 by 48 by 6 inches minimum, to demonstrate the expected range of finish, color, joint types, patching, sacking, and texture variations.

5. Preinstallation Conference: Conduct conference at Project site two weeks prior to beginning architectural concrete placement. Include installer, suppliers and factory representative for all products proposed for use in the placement procedures.

1.05 MOCK-UP
A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
B. Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship. See Section 01 43 39.
C. Construct concrete mock-ups for new architectural concrete placements indicated on the drawings, incorporating all components specified.
   1. Construct in a coordinated mock-up, concrete retaining wall mock-up where indicated on the drawings, incorporating all components specified for one coordinated assembly in conjunction with associated assemblies.
   2. Minimum size of mock-up as indicated.
   3. Approved mock-up may remain as part of the Work if undisturbed at time of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.07 SYSTEM DESCRIPTION
A. Redesign or Departures from Requirements of the Contract Documents Initiated by Contractor:
   1. Obtain written acceptance from the Architect and Architect’s consultants.
   2. Bear costs for Contractor-initiated or construction error due to changes in type, form, system, or details of construction from those indicated by the contract documents.
   3. Costs of review of such changes by Architect and Architect’s consultants will be deducted from the Contract Sum by Change Order.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection.
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Products: Subject to compliance with requirements, provide one of the products specified.
   3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to manufacturers specified.
   4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 FORM-FACING MATERIALS
A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.
   2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      a. High-density overlay, Class 1, or better.
B. Forms for Rectangular Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.


E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.

2.03 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed. Refer to General Structural Notes.

B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 60 percent.

C. Regional Content: Provide steel products which are extracted/harvested and manufactured from within 500 miles of the project site.

D. Low-Alloy-Steel Reinforcing Bars: All reinforcing steel to be welded or bent in field: ASTM A 706, deformed.

E. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.04 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615, Grade 60 plain steel bars, cut bars true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice" of greater compressive strength than concrete, and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.05 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C 150, Type I/II.
      a. Fly Ash: ASTM C 618, Class C or F. Refer to General Structural Notes.
      b. Recycled Content: Provide cement and cementitious materials with postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
      c. Regional Content: Provide cement and cementitious materials which are extracted/harvested and manufactured from within 500 miles of the project site.

B. Normal-Weight Aggregate: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source.
   1. Maximum Coarse-Aggregate Size: 1 inch at foundations, 3/4 inch at slabs and walls.
a. Regional Content: Provide aggregate materials which are extracted/harvested and manufactured from within 500 miles of the project site.

C. Water: ASTM C 94 and potable.

2.06 ADMIXTURES
   1. Use of admixtures requires Owner approval.

B. Chemical Admixtures:
   1. Use of admixtures requires Owner approval.

2.07 WATERSTOPS
A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 inch by 1 inch (19 by 25mm).
   1. Products:
      a. Colloid Environmental Technologies Company; Volclay Waterstop-RX.
      b. Concrete Sealants Inc., Conseal CS-231.
      c. Greensteak; Swellstop.
      d. Henry Company, Sealants Division; Hydro-Flex.
      e. JP Specialties, Inc.; Superstop.
      f. TCMiraDRI; Mirsastop.
      g. Substitutions: See Section 01 60 00 - Product Requirements.

B. Underslab Vapor Barrier: Polyolefin multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E 1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs.
   1. Single ply polyethylene is prohibited.
   2. Water Vapor Permeance: less than.01 perms when tested in accordance with ASTM F-1249/ASTM E-96.
   4. Manufacturers:
   5. Details, transitions, terminations and penetrations to be installed per manufacturer’s recommendations.

B. Vapor Emission Control Sealer and pH Suppression: Two-component high solids penetrating epoxy sealer for providing an effective membrane barrier to inhibit moisture migration and provide pH isolation. Details, transitions, terminations and penetrations to be installed per manufacturer’s recommendations. See Section 01 45 19 for testing procedures to determine if use of these products is necessary. Use of these products is applicable only when testing indicates need for floor covering application and individual Division 09 floor covering manufacturers do not have a preferred specific product for maintaining floor covering warranties.
   1. Manufacturers:
      a. Ardex
      b. Advanced Moisture Control
      c. Aquafin, Inc
      d. Bostik
      e. Dependable Floor Underlayments
CAST-IN-PLACE CONCRETE

f. Mapei

g. Substitutions: See Section 01 60 00 - Product Requirements.

C. Slab Isolation System: Roll-out batting with pre-spaced isolators for providing an effective high-performance resilient decoupler creating a floating floor system to minimize floor impact noise and airborne sound transmissions.
   1. Manufacturers:
      a. Kinetics Noise Control, Inc.
         1) Product: Model RIM.
      b. Substitutions: See Section 01 60 00 - Product Requirements.

D. Concrete Topical Sealer: Clear single-component high resin solids, water-based low VOC concrete sealer for providing an effective anti-dusting wear surface for exposed concrete floors which are not recieving floor covering, penetrating sealers/hardeners or polished concrete floor surfacing.
   2.09 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
   1. Products:
      a. Axim Concrete Technologies; Cimfilm.
      b. Burke by Edoco; BurkeFilm
      c. ChemMasters; Spray-Film
      d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
      e. Dayton Superior Corporation; Sure Film.
      f. Euclid Chemical Company (the); Eucobar.
      g. Kaufman Products, Inc.; Vapor Aid.
      h. Lambert Corporation; Lambco Skin.
      i. L&M Construction Chemicals, Inc.; E-Con.
      j. MBT Protection and Repair, Div. of ChemRex; Confilm.
      l. Metalcrete Industries; Waterhold.
      m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
      n. Sika Corporation, Inc.; SikaFilm.
      o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
      p. Unitex; Pro-Film.
      q. US Mix Products Company; US Spec Monofilm ER.
      r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
      s. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
   5. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A, 30% solids content minimum. The only place in the project this is applied are the top of exposed concrete slabs that are not receiving other floor finishes that cover the concrete slab visually or concrete polishing.
      a. Products:
         1) Burke By Edoco; Cureseal 1315 WB.
         2) ChemMasters; Polyseal WB.
         3) Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Sealcure 1315 WB.
         4) Euclid Chemical Company (The); Super Diamond Clear VOX.
         6) Lambert Corporation; UV Safe Seal.
2.10 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class, suitable for application temperature and grade to suit requirements, and as follows:
   1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.0217-inch (0.55-mm) thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Weep Hole Sleeve:
   1. Size: Schedule 40 standard steel pipe, 1 inch inside diameter.
   2. Finish: Hot dipped galvanized, G-185 complying with ASTM A 123/A 123 M.

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 and in accordance with the following:
   1. Compressive Strength: Refer to General Structural Notes.
   3. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having the air content specified in the General Structural Notes.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 20 percent.
   2. Combined Fly Ash and Pozzolan: 20 percent.
   4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 20 percent.
   5. Silica Fume: 10 percent.
   6. Combined Fly Ash, Pozzolans, and silica Fume: 30 percent with fly ash or pozzolans not exceeding 20 percent and silica fume not exceeding 10 percent.
   7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and silica Fume: 50 percent portland cement minimum, with fly ash or pozzolans not exceeding 20 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.12 FABRICATING REINFORCEMENT
   A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING
   A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information
      1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION
3.01 FORMWORK
   A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
   B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
   C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
      1. Class A, 1/8 inch for smooth-formed finished surfaces at interior or exterior exposed to view concrete surfaces.
      2. Class B, 1/4 inch for utility formed finished surfaces.
      3. Class C, 1/2 inch utility formed finished surfaces hidden from view.
      4. Class D, up to 1 inch for rough-formed finished surfaces buried and hidden from view.
   D. Construct forms tight enough to prevent loss of concrete mortar.
   E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
      1. Install keyways, reglets, recesses, and the like, for easy removal.
      2. Do not use rust-stained steel form-facing material.
   F. Place form ties in patterns evenly space horizontally and vertically.
   G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
   H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
   I. Chamfer exterior corners and edges of permanently exposed concrete.
   J. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
   K. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
   L. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
   M. Coat contact surfaces of forms with form-release agent, according to manufacturer’s written instructions, before placing reinforcement.
3.02 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.03 REMOVING AND REUSING FORMS

A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
   1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
   2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 SHORES AND RESHORES

A. Comply with ACI 318, and ACI 301 for design, installation, and removal of shoring and reshoring.
   1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.05 VAPOR BARRIER

A. Plastic Vapor Barrier: Place, protect, and repair vapor barrier according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.
   2. Install vapor barriers per manufacturer's recommendations.

3.06 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   1. Weld reinforcing bars according to AWS D1.4, where indicated.
D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.07 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
   3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   6. Use a bonding agent or roughen interface to ¼” (6mm) amplitude at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

3.08 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field-fabricate joints in waterstops according to manufacturer’s written instructions. Install per manufacturer’s recommendations.

3.09 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Architect.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

C. Adjust mix as required to maintain specified air content at the point of discharge.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:
   1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities to meet preparation requirements for waterproofing and dampproofing.
   1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
   2. Finish and measure surface to tolerances indicated.

C. Trowel and Fine-Broom Finish: Apply a first trowel finish, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness tolerances for trowel finished floor surfaces indicated.
D. **Broom Finish:** Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

### 3.12 FLOOR FLATNESS AND LEVELNESS TOLERANCES

**A.** An independent testing agency, as specified in Section 01 40 00, will inspect finished slabs for conformance to specified tolerances.

**B.** Screed slab on grade floors level, maintaining the following minimum F(F) Floor Flatness and F(L) Floor Levelness values when measured in accordance with ASTM E 1155 within 48 hours after slab installation; report both composite overall values and local values for each measured section. Verify finish with Architect.

1. **Non-critical areas, thickset tile:**
   a. F(F): Specified Overall Value (SOV) of 20; Minimum Localized Value (MLV) of 15.
   b. F(L): Specified Overall Value (SOV) of 15; Minimum Localized Value (MLV) of 10.

2. **Carpet areas:**
   a. F(F): Specified Overall Value (SOV) of 25; Minimum Localized Value (MLV) of 17.
   b. F(L): Specified Overall Value (SOV) of 17; Minimum Localized Value (MLV) of 15.

3. **Thinset Flooring:**
   a. F(F): Specified Overall Value (SOV) of 35; Minimum Localized Value (MLV) of 30.
   b. F(L): Specified Overall Value (SOV) of 30; Minimum Localized Value (MLV) of 20.

4. **Polished Concrete Flooring:**
   a. F(F): Specified Overall Value (SOV) of 50; Minimum Localized Value (MLV) of 35.
   b. F(L): Specified Overall Value (SOV) of N/A; Minimum Localized Value (MLV) of N/A.

**C.** Screed suspended slab floors level, maintaining the following minimum F(F) Floor Flatness and F(L) Floor Levelness values when measured in accordance with ASTM E 1155 within 48 hours after slab installation; report both composite overall values and local values for each measured section. Verify finish with Architect.

1. **Non-critical areas, thickset tile and parking structures:**
   a. F(F): Specified Overall Value (SOV) of 20; Minimum Localized Value (MLV) of N/A.
   b. F(L): Specified Overall Value (SOV) of 15; Minimum Localized Value (MLV) of N/A.

2. **Carpet Areas:**
   a. F(F): Specified Overall Value (SOV) of 25; Minimum Localized Value (MLV) of N/A.
   b. F(L): Specified Overall Value (SOV) of 15; Minimum Localized Value (MLV) of N/A.

3. **Thinset Flooring:**
   a. F(F): Specified Overall Value (SOV) of 30; Minimum Localized Value (MLV) of N/A.
   b. F(L): Specified Overall Value (SOV) of 24; Minimum Localized Value (MLV) of N/A.

4. **Polished Concrete Flooring:**
   a. F(F): Specified Overall Value (SOV) of 50; Minimum Localized Value (MLV) of 35.
   b. F(L): Specified Overall Value (SOV) of N/A; Minimum Localized Value (MLV) of N/A.

### 3.13 MISCELLANEOUS CONCRETE ITEMS

A. **Filling In:** Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. **Curbs:** Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. **Equipment Bases:** Unless shown otherwise in the drawings provide 4” thick concrete pads under mechanical equipment as required. Reinforce with #4 @16” on center each way at center of pad. Dowel to floor structure with #3 hooked dowels with 12” horizontal legs, at 24” on center around perimeter of pad. Drill and epoxy with 3” embedment. Refer to Mechanical drawings for locations. Pad size to extend 6” beyond edge of equipment on all sides. Set anchor bolts for
machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.14 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft./h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1 by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of a floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

F. General: Where structural slabs will be polished and exposed to view, protect structural concrete slab finished surface from surface damage and staining resulting from construction activities by utilizing appropriate membrane and sheet materials and other such measures as may be necessary to protect the finished slab surface appearance such as, but not limited to, diapering of equipment to eliminate oil leaks, and restricting construction activities that could be
potentially detrimental to exposed to view slab finished surfaces. Protect concrete surfaces to receive polished finish:
1. Moist cure for a minimum of 10 days before covering with protection board.
2. Use Ram Board as protection board, with additional plywood during setting of steel. Do not use Masonite, hardboard.
3. Do not use staining snap lines. Use blue only.
4. Wet cure only, concrete slabs.
5. Slab curing temperature is to remain below 120 degrees F where radiant heating/cooling system plastic piping is integral with slab.
6. Forming and bracing must remain in place for support of structural slab until slab has come up to full strength.
7. Allow slabs to adequately cure to eliminate possibility of discoloring slab surface and silhouetting of protect board onto concrete finish surface. Hardboard may not be used as a protection board.

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent
CAST-IN-PLACE CONCRETE

floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.16 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports as specified in Section 01 40 00.

B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests, and inspections and to submit test reports.

C. Inspections: As indicated in the General Structural Notes.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 150 cu. yd. or fraction thereof of each concrete mix placed each day and at least one composite sample for each 5000 square feet of surface area of slabs or walls.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

5. Prior to finish flooring surfaces being installed, the relative humidity of the concrete slab shall meet the requirements of the flooring manufacturer or 80 percent, whichever is less, per ASTM F-2170-02 (Relative Humidity Probe Test).

   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39; test one laboratory-cured specimen at 7 days, two at 28 days, and hold one for later testing.
   a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength
and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

9. Test results shall be reported in writing to Architect, Structural Engineer, concrete manufacturer, Building Official, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, type of break for both 7- and 28-day tests, and air content.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.

12. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

13. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION
CONCRETE FLOOR FINISHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Bonded abrasive polishing of exposed new and existing concrete floors to a Class B aggregate exposure and a Gloss Level of 3:
   1. Existing floor finish removal from slab.
   2. Joint and crack filler.
   5. Oil repellant sealer.

1.02 DEFINITIONS

A. Aggregate Exposure: Grinding a concrete floor surface with bonded abrasives to achieve a specified class of exposed aggregate, classified as A, B, C and D with varying levels of exposed aggregate.

B. Finished Gloss: Processing a concrete floor surface to achieve a specified level of finished gloss prior to application of any protective treatment; Flat (ground), satin (honed), semi polished, and highly polished are measured in reflective clarity (DOI), and reflective sheen (specular gloss). Finished Gloss is classified as levels 1, 2, 3 and 4 with varying degrees of reflective clarity, and sheen.

1.03 PERFORMANCE REQUIREMENTS

A. Performance Criteria for final finish:
   1. Abrasion Resistance: ASTM C779 - Up to 20-26% increase in abrasion resistance.
   2. Impact Strength: ASTM C805 - Up to 21% increase impact strength.
   4. Reflectivity: Up to 30% increase in light reflectivity.
   5. Coefficient of friction: 0.6 per ANSI 101.3.
   6. Minimum flatness and level of F(F) of 35 and F(L) of 35 per ASTM E 1155.
   7. Gloss at 60 degrees from vertical of 70 to 85 units per ASTM D 523.
   8. Slip resistance of diamond polished concrete: Provide minimum 0.8 static coefficient of friction at stairs and ramps and to qualify as a slip resistant surface per Voices of Safety International VOSI V41.21 test method.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Comply with pertinent provisions of Section 01 60 00- Product Requirements.

C. Certification of Mix Design Review: Submit finish applicator's review and acceptance of the mix design submitted per section 03 30 00 - Cast in Place Concrete for concrete flatwork to receive bonded abrasive polish finish.

D. Product data:
   1. Submit manufacturer's technical data specifications and test data giving descriptive data, curing time, and application requirements.
   2. Finished Floor Slip Resistance: Provide performance data for representative sample of similarly finished concrete flatwork demonstrating compliance with slip resistance requirements.
   3. Submit manufacturer's special concrete finish describing each product to be provided, giving manufacturer's name and product name for the specified material proposed to be provided under this section.
   4. Submit special concrete finishes technical data sheet

E. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
2. Credit MR 5: (Regional) Straight-line distance to Manufacturer and distance to material extraction for each product. If greater than 500 miles, report “> 500”. Product cost data.

3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.

F. Test Reports: Provide certified test reports, prepared by an independent testing laboratory, confirming compliance with specified performance criteria.

G. Installer's Certification.

H. Installation Instructions: Manufacturer’s recommended installation procedures and instructions for each special concrete finish; which when approved by the Architect, will become the basis for accepting or rejecting actual installation.

I. Pre-installation meeting minutes.

J. Manufacturer’s technical representative to submit to Architect and Owner’s representative field reports for each site visit.

1.05 QUALITY ASSURANCE

A. Source Quality Control: Provide concrete finishing components and materials from single manufacturer or as approved through the substitution request process.

B. Installer Qualifications:
   1. Applicator shall be familiar with the specified requirements and the methods needed for proper performance of work of this section. Applicator must have availability of proper equipment to perform work within scope of this project on a timely basis.
   2. Installer to provide manufacturer trained personnel, experienced, and skilled in application of materials and system finish specified in adequate numbers and maintain supervision over personnel.

C. Manufacturer’s Certification: Letter of certification from concrete finish manufacturer stating that installer is certified applicator of special concrete finishes, and is familiar with proper procedures and installation requirements required by the manufacturer.

D. Field Quality Control:
   1. Notify Architect and Owner’s representative a minimum of 7 days prior to any Work.
   2. Technical representative of materials manufacturer to observe Work in progress and at a minimum these other times:
      a. Pre-installation meeting.
      b. Installation of mock-up.
      c. Observation of completed installation.
   3. Document site visits in writing with copy to Architect.

1.06 MOCK-UPS:

A. Provide mock-ups of each type finish, new and existing slabs, in a selected area where new and existing are contiguous, to demonstrate typical joints, surface finished gloss, color variation (if any), aggregate exposure and standard of workmanship.
   1. Size: 100 square feet for each type (new and existing).
   2. Location: As selected by Architect.
   3. When accepted, mock-up will demonstrate minimum standard of quality required for this work.
   4. Maintain and protect mock-ups during construction in an undisturbed condition as a standard for judging the completed work.
   5. Approved mock-up may remain as part of finished work if undisturbed at time of substantial completion.
   6. Existing Slab Mock-Up:
      a. Prepare floor mock-up in advance of adjoining new slab placement so that mock-ups are at matching elevation.
      b. Slab preparation aesthetics must be approved by owner prior to beginning mock-up.
7. Notify Architect or Owner Representative seven days in advance of dates and times when mock-ups will be constructed.

1.07 PRE-INSTALLATION CONFERENCE
A. Conduct conference at Project Site two weeks before starting Work of this section.
B. Review preparation and installation procedures and coordinating and scheduling required with related Work.

1.08 DELIVERY, STORAGE AND HANDLING
A. Deliver materials in original containers, with seals unbroken, bearing manufacturer labels indicating brand name and directions for storage.
B. Dispense special concrete finish material from factory numbered and sealed containers. Maintain record of container numbers.

1.09 PROJECT CONDITIONS
A. Protection of concrete floors prior to and after finishing:
   1. No satisfactory chemical or cleaning procedure is available to remove petroleum stains from the concrete surface. Prevention is therefore essential.
   2. All hydraulic powered equipment must be diapered to avoid staining of the concrete.
   3. No trade shall park vehicles on the inside slab. If necessary to complete their scope of work, drop cloths shall be placed under vehicles at all times.
   4. No pipe cutting machine shall be used on the inside floor slab.
   5. Steel will not be placed on interior slab to avoid rust staining.
   6. Acids and acidic detergents shall not come into contact with slab.
   7. All trades shall be informed that the slab must be protected at all times.
B. Environmental limitations:
   1. Comply with manufacturers written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting topping performance.
   2. Concrete must be cured a minimum of 28 days or as directed by the manufacturer before application of hardener/sealer can begin.
   3. Application of hardener/sealer shall take place 10 days prior to installation of equipment and substantial completion, thus providing a complete, uninhibited concrete slab for application.
C. Close areas to traffic during floor application and after application, for time period recommended in writing by manufacturer.
D. Protect floor access panels from damage in new and existing exposed concrete floors. Intent is to have access panels flush to adjacent polished concrete floors.

1.10 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Ten year non-dusting warranty covering application and use of chemicals, diamond tooling and polishing equipment for installation of polished concrete floor.

PART 2 - PRODUCTS

2.01 MATERIALS
A. Hardener-Sealer-Densifier Requirements:
   1. Densifier: Nano-sized particles of reactive, amorphous colloidal silica in water.
   2. VOC Content: Zero volatile organic compounds.
   3. pH: 9.5-10.5.
   4. Consistency and Color: Non-gel forming with no visible residue or whitening when applied to concrete surfaces.
B. Joint Filler: Semi-rigid, 2-component, self-leveling, 100% solids, rapid curing, polyurea control joint and crack filler with Shore A 80 or higher hardness.
1. Type recommended by hardener-sealer-densifier manufacturer and compatible with hardener-sealer-densifier.

C. Latex Based Grout to fill exposed air pockets and aggregate lost due to grinding process
   1. Type recommended by hardener-sealer-densifier manufacturer and compatible with hardener-sealer-densifier.
   2. Bonding agent allows concrete dust to receive densification process and does not introduce colors outside of concrete matrix, no epoxy based grout product.

D. Oil Repellent Sealer: Ready to use, silane, siloxane and fluoropolymer blended water based solution sealer, quick drying, low-odor, oil and water repellent, VOC compliant and compatible with chemically hardened floors.
   1. Type recommended by hardener-sealer-densifier manufacturer and compatible with hardener-sealer-densifier.

E. Metal-bond and resin-bond diamond tooling appropriate for grinding, polishing and refinement of bonded abrasive polished concrete floor.
   1. 13 millimeter metal-bond, industrial diamond impregnated grinding segment for aggregate exposure and latex grout application.
   2. Resin bond diamond impregnated tooling for refinement and polishing.

2.02 SURFACE PREPARATION EQUIPMENT

A. Grinder: Triple-headed planetary type having fully independent speed/directional control of plate and satellite heads, with minimum 700 pounds grinding pressure and phase correction in conjunction with vacuum filtration system.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrate, with installer present, for conditions affecting performance and quality of finish. Correct conditions detrimental to timely and proper work. Do not proceed until such observations have been made, unsatisfactory conditions are corrected, and have been approved in writing to Architect.

B. Verify that base slab meet finish and surface profile requirements specified in Section 03 30 00 - Cast-In-Place Concrete, and Project Conditions above.

C. Prior to application, verify that floor surfaces are free of construction latents.

D. Concrete must be in place a minimum of 28 days or as directed by the manufacturer before application can begin.

3.02 PREPARATION

A. Protect adjacent finishes and floor that will be exposed.

B. Verify that protection is adequate daily and with each stage of finishing.

3.03 APPLICATION

A. Floor to be prepared for densifier application with specified diamond grinding steps, followed by final polishing steps:
   1. Level One (Flat / Ground) requires 150 grit metal bonded diamonds, 50 grit resin diamonds, and densifier;
   2. Level Two (Satin / Honed) requires 150 grit metal bonded diamonds, 50 grit resin diamonds, 120 grit resin diamonds, 220 grit resin diamonds, densifier and 400 grit resin diamonds;
   3. Level Three (Semi-Polished) requires same steps as Level Two, with the addition of an 800 grit resin diamond final polish; Start any of the floor finish applications in presence of manufacturer's technical representative.

B. Sealing, Hardening and Polishing of Concrete Slabs:
   1. Application is to take place at 28 days after new slab has been placed. Existing slabs with cementitious cast underlayment or fill back areas using polymer modified cementious fill should be polished no sooner than 14 days after placement.
2. Densifier shall be applied by a certified applicator, following applicable procedures as recommended by the manufacturer and as required to match approved mock-up.
3. Achieve hardening, dust-proofing, and abrasion resistance of the surface without changing the natural appearance of the concrete, except for the sheen.
4. Finish to within ½” of vertical surfaces where practical. Finish remainder of slab to vertical surface with hand held grinder/polisher.
5. Polish to pre-determined level based on approved mock-up.

C. Sealer:
1. Apply sealer on entire floor as final finish of polished concrete. Follow application directions and burnish as recommended to level required to match mock-up final sheen.

3.04 CLEANING
A. Keep work area clean and free of debris at all times.
B. Remove spatter or dusting from adjoining surfaces, as necessary, depending on grinding process.
C. Repair or replace damaged surfaces caused by preparation, polishing, or cleaning operations.
D. Remove debris from jobsite.
1. Dispose of materials in separate, closed containers in accordance with local regulations.

3.05 PROTECTION
A. Close areas to traffic during floor application and after application, for time period recommended in writing by manufacturer.
B. Final Protection of Polished Concrete:
1. Following completion of the final polishing, protect finished work until fully cured in accordance with Manufacturer’s recommendations.
2. After finish work is fully cured, and prior to opening area to traffic, protect from other trades by covering with a breathable product, such as “Ramboard” or thin curing blanket. Do not use hardboard or any wood based products in direct contact with concrete as wood tannins will leave stain patterns on concrete surface.

3.06
A. Manufacturer, Owner representative, polishing sub and responsible party for facility maintenance to review manufacture recommended maintenance program of polished floor.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Pneumatically applied concrete for delegated design shoring.

1.02 REFERENCE STANDARDS
   A. ACI 506.2 - Specification for Materials, Proportioning, and Application of Shotcrete; American Concrete Institute International; 1995.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on admixtures.
   C. Shop Drawings: Indicate formwork, and dimensions, reinforcement, accessories.
   D. Mix design test reports.

1.04 QUALITY ASSURANCE
   A. Perform Work in accordance with ACI 506.2.
   B. Design work of this section under direct supervision of a Professional Structural Engineer experienced in design of shotcrete structures and licensed in the State in which the Project is located.
   C. Applicator Qualifications: Company specializing in performing shotcrete installations, with minimum five years of documented experience.

1.05 MOCK-UP
   A. Sample Panel: Provide mock-up of sufficient size to indicate special treatment or finish required.
   B. Test Panels: Prior to starting work provide mock-up for evaluation of materials and workmanship:
   C. Locate mock-up where directed.
   D. Mock-up may remain as part of the Work.

1.06 FIELD CONDITIONS
   A. Maintain material and surrounding air temperature at minimum 50 degrees F prior to and during installation and maintain material at this minimum temperature for 7 days after completion of work. Provide equipment and cover to maintain minimum temperature.
   B. Suspend shotcrete operations during high winds, rainy weather, or near freezing temperatures when work cannot be protected.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Cement: ASTM C150, Type I - Normal; white color.
   C. Admixtures: Chemical type conforming to ASTM C494/C494M (wet mix only).
   D. Water: Clean, potable, and not detrimental to shotcrete.
   E. Curing Compound: Water-based, spray-on, penetrating curing compound and hardener; not detrimental to application of subsequent surface finish materials; containing no wax, resin, or solvents.
2.02 SHOTCRETE MIX
A. Provide wet or dry mix design that gives good compaction and low percentage of rebound, is stiff enough not to sag.
B. Conform to requirements in structural notes.

2.03 EQUIPMENT
A. Mixing Equipment: Capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous placement.
B. Delivery Equipment: Capable of discharging wet mix aggregate, cement, and water accurately, uniformly, and continuously.

2.04 SOURCE QUALITY CONTROL
A. An independent testing agency will provide inspection and testing services, as specified in Section 01 40 00.
B. Prior to start of work, testing agency will review mix proportions, gradation, and quality of aggregate.
C. Test samples in accordance with ACI 506.2.
D. Independent testing agency will test mock-up panels as follows:
   1. Drill 3 inch diameter core samples from test panels.
   2. Test for strength.
E. Modify mix design as required based on results of testing.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that conditions are acceptable and are ready to receive work.
B. Verify that field measurements are as shown on drawings.
C. Verify fabricated forms are:
   1. True to line and dimension.
   2. Adequately braced against vibration during placement.
   3. Constructed to permit escape of trapped air during gunning operations.
   4. Constructed to minimize rebound during gunning operations.
D. Verify that embedded fittings, pipe, conduits, and other items are correctly and securely placed.
E. Ensure easy access to shotcrete surfaces for screeding and finishing, and to permit uninterrupted application.

3.02 PREPARATION
A. Remove existing unsound concrete from substrate surfaces.
   1. Minimize abrupt changes in depth of area to be repaired.
   2. Remove square external corners from substrate by radiusing the edges.
B. Determine operating procedures for placement in close quarters, extended distances, or around unusual obstructions where placement velocities and mix consistency may be adjusted during application.
C. Clean and wet cementitious or absorptive substrate surfaces prior to receiving shotcrete. Keep porous surfaces damp for several hours prior to placement of shotcrete.
D. Protect adjacent surfaces not receiving shotcrete.

3.03 ALIGNMENT CONTROL
A. Provide alignment wire to establish thickness and plane of required surfaces.
B. Install alignment wire at corners and offsets not established by forms.
C. Tighten alignment wire true to line. Position adjustment devices to permit additional tightening.
3.04 APPLICATION

A. Place reinforcement in accordance with ACI 506.2.
B. Use mixing and delivery equipment capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous and uniform placement.
C. Do not apply shotcrete more than 45 minutes after adding Portland cement to the mix.
D. Do not place shotcrete on surfaces that are frozen, spongy, or where there is free water.
E. Achieve maximum compaction with minimum rebound.
F. Build-up to required thickness in multiple passes to achieve layering. Encase reinforcement with the first pass.
G. Allow each layer to take initial set before applying succeeding layers.
H. Do not permit applied shotcrete to sag, slough, or displace.
I. After initial set of final layer, remove excess material outside of forms and alignment lines.
J. Finish surface of final layer with natural gun finish.
K. Remove rebound at construction and expansion joints.
L. Remove rebound material that does not fall clear of work; discard salvaged rebound.
M. Maintain shotcrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of shotcrete.
N. Immediately after placement, protect shotcrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
O. Maintain surfaces wet for a minimum of 7 days.
P. Sound test the applied material with hammer for voids. Expose voids and replace with new shotcrete ensuring full bond with adjacent work.

3.05 FIELD QUALITY CONTROL

A. Provide additional test panels, as specified for mock-up, during the course of the work as may be requested by the testing agency.

3.06 PROTECTION

A. Do not permit applied work to damage adjacent surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Delegated design architectural precast concrete copings.
B. Delegated design architectural precast concrete stair treads.
C. Supports, anchors, and attachments.
D. Intermediate and perimeter joint seals.

1.02 REFERENCE STANDARDS
A. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2010.
B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2011.
P. PCI MNL-117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products; Precast/Prestressed Concrete Institute; 2007.
R. PCI MNL-122 - Architectural Precast Concrete; Precast/Prestressed Concrete Institute; 2007, Third Edition.
S. PCI MNL-123 - Design and Typical Details of Connections for Precast and Prestressed Concrete; Precast/Prestressed Concrete Institute; 1988, Second Edition.
T. PCI MNL-135 - Tolerance Manual for Precast and Prestressed Concrete Construction; Precast/Prestressed Concrete Institute; 2000.

1.03 DESIGN REQUIREMENTS
A. Design units to withstand design loads as calculated in accordance with Building code, and erection forces. Calculate structural properties of units in accordance with ACI 318.
B. Design units to withstand static loads and anticipated dynamic loading, including positive and negative wind loads and thermal movement loads.
C. Design and size components to withstand seismic loads and sway displacement as calculated in accordance with Building code.
D. Design units to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

E. Design component connections to accommodate building movement and thermal movement. Provide adjustment to accommodate misalignment of structure without unit distortion or damage.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's information on accessory products, including pigments, admixtures, inserts, plates, etc.
C. Shop Drawings: Indicate layout, unit locations, configuration, unit identification marks, reinforcement, connection details, support items, location of lifting devices, dimensions, openings, and relationship to adjacent materials. Provide erection drawings.
D. Samples: Submit two stair tread and coping samples, 4 x 4 inch in size, illustrating surface finish, color and texture.
E. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
2. Credit MR 5: (Regional) Straight-line distance to Manufacturer and distance to material extraction for each product. If greater than 500 miles, report “> 500”. Product cost data.
3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
F. Maintenance Data: Indicate surface cleaning instructions.

1.05 QUALITY ASSURANCE
A. Perform the work of this section in accordance with PCI MNL-117, PCI MNL-120, PCI MNL-122, PCI MNL-123, PCI MNL-135, and ACI 318. Perform welding in accordance with AWS D1.1.
B. Fabricator Qualifications:
   1. Plant certified under Precast/Prestressed Concrete Institute Plant Certification Program; product group and category A1 - Architectural Precast Concrete.
C. Design Engineer Qualifications: Design precast concrete units under direct supervision of a Professional Engineer experienced in design of precast concrete and licensed in the State in which the Project is located.
D. Welder: Qualified within previous 12 months in accordance with AWS D1.1 and AWS D1.4.

1.06 PRE-INSTALLATION MEETING
A. Convene one week prior to commencing work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Handling: Lift and support precast units only from support points.
B. Protect units to prevent staining, chipping, or spalling of concrete.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Architectural Precast Concrete:
   1. Any manufacturer holding a PCI Group A Plant Certification for the types of products specified; see www.pci.org.
6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PRECAST UNITS
A. Precast Architectural Concrete Units: Comply with PCI MNL-120, PCI MNL-122, PCI MNL-123, PCI MNL-135, and ACI 318.
   1. Design Loads: Static loads, anticipated dynamic loading, including positive and negative wind loads, thermal movement loads, and erection forces as defined by applicable code.
   2. Calculate structural properties of units in accordance with ACI 318.
   3. Accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
   4. Provide connections that accommodate building movement and thermal movement and adjust to misalignment of structure without unit distortion or damage.
B. Copings:
   1. Coping 1: Match existing profile, as indicated on drawings.
   2. Coping 2: Match profile, as indicated on drawings.
C. Stair Treads and Risers:
   1. 6'-0" long, 12" deep, 5" thick, with embeds at side, must clear span 6 feet.
   2. Provide custom stainless steel profile embedded nosing protection.
   3. Quantity: As indicated.

2.03 REINFORCEMENT
A. Reinforcing Steel: ASTM A615/A615M Grade 60 (420).
   1. Deformed billet-steel bars.
   2. Epoxy coated in accordance with ASTM A775/A775M.

2.04 CONCRETE MATERIALS
A. Cement: ASTM C150, Type I - Normal Portland type.
C. Water: Clean and not detrimental to concrete.
E. Water Reducing Admixtures: ASTM C 494 Types A and F by MasterBuilders or WR Grace, recommended for use by Manufacturer.

2.05 SUPPORT DEVICES
A. Connecting and Support Devices: ASTM A 36/A 36M steel; hot-dip galvanized in accordance with ASTM A153/A 153M.
   1. Clean surfaces of rust, scale, grease, and foreign matter.

2.06 ACCESSORIES
A. Sealant: Exterior Joint type specified in Section 07 90 05.

2.07 MIX
A. Concrete: Minimum 7000 psi, 28 day strength, air entrained to 5 to 7 percent in accordance with ACI 301.

2.08 FABRICATION
A. Fabricate in conformance with PCI MNL-117 and PCI MNL-135.
B. Fabricate and handle epoxy-coated reinforcing bars in accordance with ASTM D3963/D3963M.
2.09 FINISH - PRECAST UNITS

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that building structure, anchors, devices, and openings are ready to receive work of this section.

3.02 PREPARATION
   A. Provide for erection procedures and induced loads during erection. Maintain temporary bracing in place until final support is provided.

3.03 ERECTION
   A. Erect units without damage to shape or finish. Replace or repair damaged panels.
   B. Erect units level and plumb within allowable tolerances.

3.04 TOLERANCES
   A. Erect members level and plumb within allowable tolerances. Conform to PCI MNL-135, except as specifically amended below.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
A. Liquid applied, cementitious self-leveling floor underlayment.
B. Sealer

1.02  QUALITY ASSURANCE
A. Applicator Qualifications: Company specializing in performing the work of this section and approved by manufacturer.

1.03  DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Keep dry and protect from direct sun exposure, freezing, and ambient temperature greater than 105 degrees F.

1.04  REGULATORY REQUIREMENTS
A. Conform to applicable code for combustibility or flame spread requirements.

1.05  MOCK-UP
A. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Prepare mock-up in location designated by Architect.
   2. Do not proceed with underlayment work until workmanship of mock-up has been approved by Architect.
B. Construct mock-up of underlayment material, minimum 10 feet long by 10 feet wide, illustrating all portions of specified work.
C. Locate where directed.
D. Mock-up may remain as part of the Work.

1.06  FIELD CONDITIONS
A. Do not install underlayment until floor penetrations and peripheral work are complete.
B. Maintain minimum ambient temperatures of 50 degrees F 24 hours before, during and 72 hours after installation of underlayment.
C. During the curing process, ventilate spaces to remove excess moisture.

PART 2  PRODUCTS

2.01  MANUFACTURERS
A. Cementitious Underlayment:
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  MATERIALS
A. Cementitious Underlayment: Blended cement mix, that when mixed with water in accordance with manufacturer's directions will produce self-leveling underlayment with the following properties:
   1. Flexural Strength: Minimum 1000 psi after 28 days, tested per ASTM C348.
   3. Final Set Time: 1-1/2 to 2 hours, maximum.
   4. Thickness: Capable of thicknesses from feather edge to maximum 3-1/2 inch.
CAST UNDERLAYMENT

6. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0 in accordance with ASTM E84.

B. Water: Potable and not detrimental to underlayment mix materials.

C. Primer: Manufacturer's recommended type.

D. Joint and Crack Filler: Latex based filler, as recommended by manufacturer.

E. Sealer: Manufacturer's standard sealer that is compatible and accepted by finish flooring materials.

2.03 MIXING
A. Site mix materials in accordance with manufacturer's instructions.

B. Mix to self-leveling consistency without over-watering.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that substrate surfaces are clean, dry, unfrozen, do not contain petroleum byproducts, or other compounds detrimental to underlayment material bond to substrate.

3.02 PREPARATION

B. Vacuum clean surfaces.

C. Prime substrate in accordance with manufacturer's instructions. Allow to dry.

D. Close floor openings.

3.03 APPLICATION
A. Install underlayment in accordance with manufacturer's instructions.

B. Place to indicated thickness, with top surface level to 1/8 inch in 10 ft.

3.04 CURING
A. Once underlayment starts to set, prohibit foot traffic until final set has been reached.

B. Air cure in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL
A. An independent testing agency will perform field inspection and testing, as specified in Section 01 40 00.

B. Placed Material: Agency will inspect and test for conformance to specification requirements.

1. Prepare compression test cubes for each placement of 1,000 square feet or less.

3.06 PROTECTION
A. Protect against direct sunlight, heat, and wind; prevent rapid drying to avoid shrinkage and cracking.

B. Do not permit traffic over unprotected floor underlayment surfaces.

3.07 SEALER
A. Sealing: Seal all areas that receive glue down floor goods, including but not limited to; bathrooms, toilet rooms, laundry areas, and all areas within 10 feet of all other sinks with manufacturer's approved sealer and according to the manufacturer's specifications. Any floor areas where the surface has been damaged shall be cleaned and sealed regardless of floor covering or location. Where floor goods manufacturers require special adhesive or installation systems, their requirements supersede these recommendations.

B. Floor Goods Procedures: See the manufacturer's "Procedures for Attaching Finished Floor Goods to Underlayments" brochure for guidelines for installing finished floor goods.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of existing exterior masonry for cleaning.
B. Provide two sets of test panels of cleaning products to determine final product.
C. Provide restoration cleaning for existing exterior walls.
D. Testing of existing masonry.
E. Anchors for existing masonry

1.02 SUBMITTALS

A. Product Submittals:
   1. Comply with requirements in Section 01 33 00, Submittals.
   2. Submit manufacturer's product data on cleaning materials.
B. Test Results:
   1. Cleaning and pointing results
   2. Destructive pull test report.

1.03 QUALITY ASSURANCE

A. Contractor Qualifications: All work shall be preformed by contractor/s skilled in the application and removal of the products specified in this section. Contractor shall have 10-years experience in applying work of similar scope and scale.
B. Manufacturer: Contractor to contact product manufacturer for any extra training, if required and discussion of equipment needed for application and removal of products. Manufacturers to consult with contractor on product selection and attend field patch tests for mock-ups.
C. Field Samples:
   1. Test locations shall occur in two stages. Stage one shall test the efficacy of environmentally sensitive products. If the results of stage one are not approved, stage two shall test the efficacy of stronger chemical cleaners.
   2. Provide two sets of three (3) test locations (A, B, and C) with surface cleaned and joints tuckpointed and tooled to match original existing mortar.
   3. Test locations shall be used to approve manufacturer, product, and concentration level of cleaning product.
   4. Stage one test location shall show three (3) cleaned areas, 3 feet wide x 6 feet high, separated by uncleaned existing areas 2 feet wide x 6 feet high.
   5. Stage two test locations shall show three (3) cleaned areas, 3 feet wide x 6 feet high, separated by uncleaned existing areas 2 feet wide x 6 feet high. Location A shall use 10% concentration level, location B shall use 25% concentration level, and location C shall use 50% concentration level of cleaner. Each manufacturer specified shall be applied at each location.
   6. Accepted field samples may be incorporated in the Work.
D. Field Pull Tests:
   1. Perform (4) destructive pull tests to failure per wall where anchor is to be installed.
   2. Tests Locations: As indicated on drawings.

1.04 SITE CONDITIONS

A. Temperature and Moisture Requirements:
   1. Protect mortar from excessive moisture during installation.
   2. Do not install mortar when ambient air temperature falls below 40 degrees F or rises above 90 degrees F.
B. Scheduling:
   1. Schedule cleaning after new and tuckpointed mortar joints have cured for 28 days minimum.
PART 2 PRODUCTS

2.01 CONTRACTORS/APPLICATORS
A. D & R Masonry Restoration, Inc. Portland OR.
C. Western Waterproofing Co, 503-239-7075.
D. Pioneer, Seattle, WA  206.782.4331
E. Hydro Tech Inc., UT
F. Substitutions:  See Section 01 60 00 - Product Requirements.

2.02 MANUFACTURERS
A. Approved Manufacturers:
   1. Pro So Co., Inc., Kansas City, KS, 800-255-4255
   2. Edison Coatings, Inc., Waterbury, CT, 203-597-9727
   4. Substitutions:  See Section 01 60 00 - Product Requirements.
B. Manufacturer shall be determined through approval of test panel prior to commencing cleaning operations.

2.03 MATERIALS
A. Cleaning Materials:
   1. Restoration cleaner shall be determined through approval of test panel prior to commencing cleaning operations.
   2. The following materials are presented for bid purposes only.  Final materials shall be determined by test panels.
      a. Stage one masonry cleaners:
         2) Simple Green, Simple Green.
         3) Diedrich Technologies, Envire-Store 100.
      b. Stage two masonry cleaners
         1) Pro So Co., Sure Klean Restoration Cleaner.
         2) Diedrich Technologies, 101 Masonry Restorer.
      c. Stone cleaner:
         1) Pro So Co., Sure Klean Light-Duty Restoration Cleaner.
         2) Diedrich Technologies, 101 Masonry Restorer.
      d. Biological Cleaners
         1) 1) Pro So Co., Enviro Klean BioKlean.
B. Masonry Restoration Anchors:  Reinforcing Anchors for Existing Masonry:
      a. Anchor Size: 10mm dia. x 170 mm
      b. Minimum Embedment: As indicated on drawings.
      c. Anchor Spacing: As indicated on drawings.

C. Mortar:Repointing mortar, see Section 04 20 01.
   1. Repointing to b figured at 25 percent of reinforced wall areas.

D. Water Repellant: See Section 07 19 00.
E. Graffiti Repellant: See Section 07 19 00.

PART 3 EXECUTION

3.01 PERFORMANCE
A. Test Panel:
   1. Prepare test area(s) before commencing with full-scale cleaning operations.
2. Test panel shall be used to determine dilution rates, compatibility with surfaces, dwell time and number of applications necessary for complete stripping, and desired results.
3. Test each surface and each type of product.
4. Test to see what effect pressure rinsing may have on older masonry.
5. Allow test panels to dry three to seven days.
6. Make the test panel available for inspection and approval before proceeding with overall cleaning.

B. General:
1. Follow manufacturer’s safety precautions.
2. Cleaners are corrosive, etch glass and architectural aluminum and are harmful to wood, painted surfaces and foliage. BEWARE OF WIND DRIFT.
3. Complete masonry cleaning before replacement of windows, doors, hardware, light fixtures, roofing materials, wood and any other non-masonry items which may be damaged by the cleaning product. If such fixtures have been installed or are to remain in place, protect using polyethylene sheets before overall application.
4. Be sure that all caulking and sealant materials are in place and thoroughly cured before cleaning begins.
5. Protect surrounding metal painted surfaces, wood, adjacent plant life and all other non-masonry materials from exposure to the cleaning solutions and fumes.
6. Take precautions to avoid harm to building occupants, pedestrians, nearby property and all non-masonry surfaces by contact with the cleaner, rinse, water, or fumes.
7. Beware of drifting of sprayed material or rinse residue.
8. Pedestrian and auto traffic must be diverted or protected. Do not work over traffic. Consideration must be given to working in the evenings.
9. Do not clean when temperatures are below freezing or will be overnight. Best cleaning results are obtained when air and masonry surface temperatures are 40 degrees F or above. If freezing conditions exist prior to application, allow adequate time for masonry to thaw.
10. Inspect the surface carefully.
11. Follow manufacturer’s recommendations for proper containers for each solution.

C. Solution:
1. Follow test panel results for strength and dilution methods for each solution.
2. Restrict pressure from 50-300 psi or hand rinsing.

D. Water Rinse Application:
1. Low pressure water rinse application 50-300 psi.
2. Note: Application of rinse water is extremely important. As much water as possible should be used to assure that all staining elements are completely removed. Pressure rinsing equipment with at least 50-300 psi and 15-30 degree fan tip will prove most effective. Older, more delicate masonry may require restricting water pressure to avoid damage.

E. Equipment:
1. Cleaning equipment shall be equipped with pressure control unit.
2. Use a 30-60 degree fan tip.
3. Maintain a minimum of 12 inches’ distance from surface during cleaning process.

F. Adjusting and Cleaning:
1. Examine existing units, replaced units, and mortar joints.
2. Remove debris and loose mortar from the site.
3. Remove acid and water mixes from the site.
4. Remove restoration cleaner and water mixes from the site.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. General cleaning of exterior limestone
B. Repair and replacement of damaged exterior limestone.
C. Equipment.

1.02  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide technical data for each product indicating chemical analysis, recommendations for their application and use, and any other available technical data. Include test reports and certifications substantiating that products comply with requirements.
C. Samples:
   1. Clearly labelled samples of all materials to be used on the project for approval before work starts.
   2. Approved samples will become the standard materials used on the job. Substitutions will not be permitted.
D. Quality Control Submittals:
   1. Submit written program for each phase of process including protection of surrounding materials during.
   2. The approved samples will become the standard materials.
E. LEED Submittals: Report recycled content and source of product.
F. Maintenance Data: Include cleaning instructions, and stain removal procedures.

1.03  QUALITY ASSURANCE

A. Contractor Qualifications: All work shall be performed by contractor/s skilled in the application and removal of the products specified in this section. Contractor shall have 10-years experience in applying work of similar scope and scale.
B. Manufacturer: Contractor to contact product manufacturer for any extra training, if required and discussion of equipment needed for application and removal of products. Manufacturers to consult with contractor on product selection and attend field patch tests for mock-ups.
C. Field Samples:
   1. Test locations shall occur in two stages. Stage one shall test the efficacy of environmentally sensitive products. If the results of stage one are not approved, stage two shall test the efficacy of stronger chemical cleaners.
   2. Provide two sets of three (3) test locations (A, B, and C) with surface cleaned and joints tuckpointed and tooled to match original existing mortar.
   3. Test locations shall be used to approve manufacturer, product, and concentration level of cleaning product.
   4. Stage one test location shall show three (3) cleaned areas, 3 feet wide x 6 feet high, separated by uncleaned existing areas 2 feet wide x 6 feet high.
   5. Stage two test locations shall show three (3) cleaned areas, 3 feet wide x 6 feet high, separated by uncleaned existing areas 2 feet wide x 6 feet high. Location A shall use 10% concentration level, location B shall use 25% concentration level, and location C shall use 50% concentration level of cleaner. Each manufacturer specified shall be applied at each location.
   6. Accepted field samples may be incorporated in the Work.

PART 2  PRODUCTS

2.01  MATERIALS

A. Cleaning Materials:
   1. Restoration cleaner shall be determined through approval of test panel prior to commencing cleaning operations.
2. The following materials are presented for bid purposes only. Final materials shall be determined by test panels.
   a. Stone cleaner:
      1) Pro So Co., Sure Klean Light-Duty Restoration Cleaner.
      2) Diedrich Technologies, 101 Masonry Restorer.
      3) Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 PERFORMANCE

A. Test Panel:
   1. Prepare test area(s) before commencing with full-scale cleaning operations.
   2. Test panel shall be used to determine dilution rates, compatibility with surfaces, dwell time and number of applications necessary for complete stripping, and desired results.
   3. Test each surface and each type of product.
   4. Test to see what effect pressure rinsing may have on older stone.
   5. Allow test panels to dry three to seven days.
   6. Make the test panel available for inspection and approval before proceeding with overall cleaning.

B. General:
   1. Follow manufacturer’s safety precautions.
   2. Cleaners are corrosive, etch glass and architectural aluminum and are harmful to wood, painted surfaces and foliage. Beware of wind drift.
   3. Complete stone cleaning before replacement of windows, doors, hardware, light fixtures, roofing materials, wood and any other non-stone items which may be damaged by the cleaning product. If such fixtures have been installed or are to remain in place, protect using polyethylene sheets before overall application.
   4. Be sure that all caulking and sealant materials are in place and thoroughly cured before cleaning begins.
   5. Protect surrounding metal painted surfaces, wood, adjacent plant life and all other non-stone materials from exposure to the cleaning solutions and fumes.
   6. Take precautions to avoid harm to building occupants, pedestrians, nearby property and all non-stone surfaces by contact with the cleaner, rinse, water, or fumes.
   7. Beware of drifting of sprayed material or rinse residue.
   8. Pedestrian and auto traffic must be diverted or protected. Do not work over traffic. Consideration must be given to working in the evenings.
   9. Do not clean when temperatures are below freezing or will be overnight. Best cleaning results are obtained when air and stone surface temperatures are 40 degrees F or above. If freezing conditions exist prior to application, allow adequate time for stone to thaw.
  10. Inspect the surface carefully.
  11. Follow manufacturer’s recommendations for proper containers for each solution.

C. Solution:
   1. Follow test panel results for strength and dilution methods for each solution.
   2. Restrict pressure from 50-300 psi or hand rinsing.

D. Water Rinse Application:
   1. Low pressure water rinse application 50-300 psi.
   2. Note: Application of rinse water is extremely important. As much water as possible should be used to assure that all staining elements are completely removed. Pressure rinsing equipment with at least 50-300 psi and 15-30 degree fan tip will prove most effective. Older, more delicate stone may require restricting water pressure to avoid damage.

E. Equipment:
   1. Cleaning equipment shall be equipped with pressure control unit.
   2. Use a 30-60 degree fan tip.
   3. Maintain a minimum of 12 inches’ distance from surface during cleaning process.
F. Adjusting and Cleaning:
   1. Examine existing units, replaced units, and mortar joints.
   2. Remove debris and loose mortar from the site.
   3. Remove acid and water mixes from the site.
   4. Remove restoration cleaner and water mixes from the site.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Concrete Block.
B. Mortar and Grout.
C. Reinforcement and Anchorage.
D. Lintels.
E. Accessories.

1.02 REFERENCE STANDARDS
A. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures and Related Commentaries; American Concrete Institute International; 2011.
G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
C. Samples: Submit four samples of decorative block units to illustrate color, texture, and extremes of color range.
D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
E. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.
F. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture.
1.04 QUALITY ASSURANCE
   A. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.

1.05 MOCK-UP
   A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories and structural backup in mock-up.
   B. Locate where directed.
   C. Approved mock-up may remain as part of the Work.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
   B. Handle and store ceramic glazed masonry units in protective cartons or trays. Do not remove from protective packaging until ready for installation.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS
   A. Concrete Block: Comply with referenced standards and as follows:
      1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depths as indicated on the drawings for specific locations.
      2. Special Shapes: Provide non-standard blocks configured for corners.
      3. Load-Bearing Units: ASTM C90, normal weight.
         a. Hollow block, as indicated.
         b. Exposed faces: Manufacturer's standard color and texture where indicated.

2.02 MORTAR AND GROUT MATERIALS
   A. Portland Cement: ASTM C150, Type I; color as required to produce approved color sample.
      1. Hydrated Lime: ASTM C207, Type S.

2.03 REINFORCEMENT AND ANCHORAGE
   A. Reinforcing Steel: ASTM A615/A615M Grade 40 (280) deformed billet bars; galvanized.
   B. Single Wythe Joint Reinforcement: Truss type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

2.04 FLASHINGS
   A. Metal Flashing Materials: Copper, as specified in Section 07 62 00.

2.05 ACCESSORIES
   A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
      1. Manufacturers:
         d. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding.
      1. Manufacturers:
d. Substitutions: See Section 01 60 00 - Product Requirements.

C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.

D. Building Paper: ASTM D226, Type I ("No.15") asphalt felt.

E. Nailing Strips: Softwood lumber, preservative treated; as specified in Section 06 10 00.

F. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.06 MORTAR AND GROUT MIXES

A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
   1. Type S for all applications.

B. Mortar for Unit Masonry: See Structural Notes.

C. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

D. Grout: ASTM C476. Consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

E. Grout: See Structural Notes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COLD AND HOT WEATHER REQUIREMENTS

A. Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

3.04 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.

3.05 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Lay hollow masonry units with face shell bedding on head and bed joints.

C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

D. Remove excess mortar and mortar smears as work progresses.

E. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
F. Interlock intersections and external corners, except for units laid in stack bond.
G. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
I. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
J. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
K. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.06 REINFORCEMENT AND ANCHORAGE - GENERAL
A. Reinforce as indicated on drawings.

3.07 LINTELS
A. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.

3.08 GROUTED COMPONENTS
A. Lap splices minimum per lap splice schedule, see Structural Notes.
B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
C. Place and consolidate grout fill without displacing reinforcing.

3.09 CONTROL AND EXPANSION JOINTS
A. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

3.10 BUILT-IN WORK
A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.
B. Install built-in items plumb, level, and true to line.
C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
   1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
D. Do not build into masonry construction organic materials that are subject to deterioration.

3.11 TOLERANCES
A. Maximum Variation from Alignment of Columns: 1/4 inch.
B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.12 CUTTING AND FITTING
A. Cut and fit for chases. Coordinate with other sections of work to provide correct size, shape, and location.
B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.
3.13 FIELD QUALITY CONTROL
   A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.

3.14 CLEANING
   A. Remove excess mortar and mortar droppings.
   B. Replace defective mortar. Match adjacent work.
   C. Clean soiled surfaces with cleaning solution.
   D. Use non-metallic tools in cleaning operations.

3.15 PROTECTION
   A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clay Facing Brick.
B. Mortar and Grout.
C. Reinforcement and Anchorage.
D. Flashings.
E. Installation of Lintels.
F. Accessories.

1.02 REFERENCE STANDARDS

A. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures and Related Commentaries; American Concrete Institute International; 2011.
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
G. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale); 2013.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar.
C. Shop Drawings: Prepare elevation drawings indicating locations and size of horizontal and vertical control and expansion joints as dictated by industry standard requirements.
D. Samples: Submit two samples of facing brick and exterior CMU units to illustrate color, texture, and extremes of color range.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit MR 3: Salvaged, refurbished or reused materials; product cost data.
   3. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   4. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   5. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
F. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
1.04 QUALITY ASSURANCE
A. Comply with recommendations and distributed standards of the Masonry Institute of Oregon including "Technical Notes on Brick Construction" by Brick Industry Association (BIA) and "TEK Manual for Concrete Masonry Design and Construction" by National Concrete Masonry Association (NCMA).
B. Source Limitations: Obtain exposed masonry units of a uniform texture and color, or a uniform blend with the ranges accepted for these characteristics, through a single source from a single manufacturer for each product required.

1.05 MOCK-UP FOR APPROVAL
A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories and structural backup in mock-up.
B. Locate where directed.
C. Include a sealant-fill joint.
D. Refer to Section 08 44 13 for additional Mockup information. Refer to drawings for mockup location. Include studs, sheathing, veneer anchors, flashings, through-wall flashing and weep holes.

1.06 PRE-INSTALLATION MEETING
A. Convene one week before starting work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.08 FIELD CONDITIONS
A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

PART 2 PRODUCTS
2.01 BRICK UNITS
A. Manufacturers:
         1) BR-1:
            (a) Color: Forest Blend.
            (b) Texture: Mission
         2) BR-2:
            (a) Color: White
            (b) Texture: Smooth
   2. Substitutions: See section 01 60 00 - Product requirements.
B. Facing Brick: ASTM C216, Type FBS, Grade SW.
   1. Actual size: As indicated on drawings.
   2. Special shapes: Molded units as required by conditions indicated, unless standard units can be sawn to produce equivalent effect.

2.02 MORTAR AND GROUT MATERIALS
A. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
B. Hydrated Lime: ASTM C207, Type S.
C. Mortar Aggregate: ASTM C144.
E. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
   1. Color at BR-1: Dark grout color to match Architect's sample.
   3. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
   4. Colors: As required to match Architect's color samples.

F. Water: Clean and potable.

G. Accelerating Admixture: Nonchloride type for use in cold weather.

H. Moisture-Resistant Admixture: Water repellent compound designed to reduce capillarity.

2.03 REINFORCEMENT AND ANCHORAGE

A. Joint Reinforcement: Truss type; stainless steel wire conforming to ASTM A580/A580M Type 304; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

B. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, stainless steel conforming to ASTM A580/A580M, Type 304.
   1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
   2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
   3. Vertical adjustment: Not less than 3-1/2 inches.
   4. Seismic Feature: Provide lip, hook, or clip on end of wire ties to engage or enclose not less than one continuous horizontal joint reinforcement wire of 0.1483 inch diameter.

C. Metal-to-Metal Fasteners: Self-drilling, self-tapping screws: Stainless steel

D. Metal-to-Metal Fasteners: Self-drilling, self-tapping screws; corrosion resistant finish or hot dip galvanized to ASTM A153/A153M.

2.04 FLASHINGS

A. Stainless Steel: ASTM A666, Type 304, soft temper; 26 gage (0.45 mm) thick; finish 2B to 2D.

2.05 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.

B. Weeps: Polyester mesh.

C. Cavity Vents: Polyester mesh.

D. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage. Provide system manufactured by Mortar Net.

E. Sealant: Silicone type specified in Section 07 90 05
   1. Sealant Joints: Sanded type with sand color to match moter color.

F. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

G. Water Repellant and Anti-Graffiti Coatings: See Section 07 19 00.

2.06 MORTAR MIXES

   1. Masonry below grade and in contact with earth: Type S.
   2. Exterior, non-loadbearing masonry: Type N.
   3. Interior, non-loadbearing masonry: Type S.
B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

C. Grout: ASTM C476. Consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field conditions are acceptable and are ready to receive masonry.
B. Verify that related items provided under other sections are properly sized and located.
C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 COURSING
A. Establish lines, levels, and coursing indicated. Protect from displacement.
B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
C. Brick Units:
   1. Bond: Running.
   2. Coursing: Three units and three mortar joints to equal 8 inches.

3.03 PLACING AND BONDING
A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
B. Remove excess mortar as work progresses.
C. Interlock intersections and external corners.

3.04 WEEPS/CAVITY VENTS
A. Install weeps in veneer walls at 24 inches on center horizontally above through-wall flashing.
B. Install cavity vents in veneer walls at 32 inches on center horizontally below shelf angles and lintels and at top of walls.

3.05 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER
A. Seismic Reinforcement: Connect veneer anchors with continuous horizontal wire reinforcement before embedding anchors in mortar.

3.06 MASONRY FLASHINGS
A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

3.07 LINTELS
A. Install structurally anchored lintels over openings.

3.08 CONTROL AND EXPANSION JOINTS
A. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

3.09 TOLERANCES
A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.

3.10 CUTTING AND FITTING

A. Cut and fit for pipes and conduit. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.11 CLEANING

A. Clean soiled surfaces with cleaning solution.

B. Use non-metallic tools in cleaning operations.

3.12 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A.  Cut limestone veneer at exterior rainscreen walls.
   B.  Metal anchors and supports.

1.02  REFERENCE STANDARDS
   A.  ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

1.03  ADMINISTRATIVE REQUIREMENTS
   A.  Preinstallation Meeting: Convene one week before starting work of this section.

1.04  SUBMITTALS
   A.  See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B.  Product Data: Provide data on stone, mortar products, and sealant products.
   C.  Shop Drawings: Indicate layout, pertinent dimensions, anchorages, head, jamb, and sill opening details, and jointing methods.
   D.  Samples: Submit three stone samples 6 x 24 inch in size, illustrating color range and texture, markings, surface finish.

1.05  QUALITY ASSURANCE
   A.  Perform work in accordance with ILI Indiana Limestone Handbook.
   B.  Perform work in accordance with Vetter Stone Company Limestone Handbook.
   C.  Stone Fabricator: Company specializing in fabricating cut stone with minimum ten years of documented experience.
   D.  Installer Qualifications: Company specializing in performing the work of this section with minimum ten years of experience and three projects completed in the last five of similar size and complexity.

1.06  FIELD CONDITIONS
   A.  During temporary storage on site, at the end of working day, and during rainy weather, cover stone work exposed to weather with non-staining waterproof coverings, securely anchored.

PART 2  PRODUCTS

2.01  STONE
   A.  Limestone: Indiana Oolitic Limestone; complying with ASTM C568 Classification II - Medium Density.
         a.  Grade: ILI Standard.
         b.  Color: Silver Shadow.
         c.  Cut: Fleuri
         d.  Surface Texture: Honed.
         e.  Acceptable Producers:
             2)  Substitutions: See Section 01 60 00 - Product Requirements.

2.02  ANCHORS AND ACCESSORIES
   A.  Anchors and Other Components in Contact with Stone: Stainless steel, ASTM A666, Type 304.
1. Sizes and Configurations: As required by delegated design for vertical and horizontal support of stone and applicable loads; see Section 05 40 10.
2. Wire ties are not permitted.
B. Support Components not in Contact with Stone: Stainless steel, ASTM A167, Type 304.
C. Setting Buttons and Shims: Lead type.
D. Flashings: Stainless steel, Type 304.

2.03 STONE FABRICATION
A. Thickness: 1 1/4 inch.
B. Fabricate units for uniform coloration between adjacent units and over the full area of the installation.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that support work and site conditions are ready to receive work of this section.
B. Verify that items built-in under other sections are properly located and sized.

3.02 PREPARATION
A. Clean stone prior to erection. Do not use wire brushes or implements that will mark or damage exposed surfaces.

3.03 INSTALLATION
A. Install flashings of longest practical length and seal watertight to back-up. Lap end joint minimum 6 inches and seal watertight.
B. Set stone with a consistent joint width of 3/8 inch.
C. Install anchors and place setting buttons to support stone and to establish joint dimensions.

3.04 TOLERANCES
A. Positioning of Elements: Maximum 1/4 inch from true position.
B. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet; 1/2 inch in 50 feet.
C. Maximum Variation Between Face Plane of Adjacent Panels: 1/16 inch.
D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in any two stories.
E. Maximum Variation from Level Coursing: 1/8 inch in 3 feet; 1/4 inch in 10 feet; 1/2 inch maximum.
F. Maximum Variation of Joint Thickness: 1/8 inch in 3 feet.

3.05 CUTTING AND FITTING
A. Obtain approval prior to cutting or fitting any item not so indicated on Drawings.
B. Do not impair appearance or strength of stone work by cutting.

3.06 CLEANING
A. Clean soiled surfaces with cleaning solution.
B. Use non-metallic tools in cleaning operations.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Structural steel framing members, support members, and struts.
   B. Base plates, shear stud connectors and expansion joint plates.
   C. Grouting under base plates.

1.02 REFERENCE STANDARDS
   L. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2013.
   N. ASTM A490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric); 2012.
   O. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010a.


AB. ASTM F436M-93 - Specification for Hardened Steel Washers (Metric); 2000.

AC. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2009.


AE. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.


1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: For each type of product indicated.

C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 35 15, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.

1. Credit MR 4: Recycled content for each product, post-consumer and post-industrial.
   Product cost data.

2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured or processed within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture, product cost data.

D. Shop Drawings: Show fabrication of structural-steel components.

1. Structural steel shop drawings shall contain sufficient detail and information to allow complete fabrication and erection of the structure without reference to the contract drawings either on the fabrication shop floor or at the project site. The steel detailer shall generate all shop drawing fabrication and installation details from the structural and architectural drawings and specifications. The use of reproductions or photocopies of the contract drawings shall not be permitted.

2. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.

3. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

4. Include embedment drawings.

5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

6. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.

7. Additional seismic submittal requirements:
   a. Identify members and connections that are part of the SLRS as indicated in the construction documents.
   b. Locations of demand critical welds.
   c. Locations and dimensions of protected zones.
   d. Locations of slip critical bolts.
   e. Access hole dimensions, surface profile and finish requirements.
f. Locations where backing bars and weld tabs are to be removed.
g. Locations where supplemental fillet welds are required when backing in permitted to remain.
h. Connection assembly sequence where special precautions are required.
i. Non-Destructive Testing (NDT) to be performed by the fabricator, if any.
k. AWS D1.8/D1.8M – Structural Welding Code – Seismic Supplement; 2009.

8. Shop drawing re-submittals shall clearly identify all revisions to previous submittals.
a. Heavy ink, clouded outlines (revision clouds) shall be drawn around revised areas of individual sheets.
b. Engineer/Architect will not review information outside of revision clouds on resubmitted drawings.

E. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
F. Mill Test Reports: Indicate structural strength, destructive test analysis and non-destructive test analysis.
G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.
H. See structural drawings for additional requirements.

1.04 QUALITY ASSURANCE
A. Fabricate structural steel members in accordance with AISC "Steel Construction Manual."
B. Comply with Section 10 of AISC "Code of Standard Practice for Steel Buildings and Bridges" for architecturally exposed structural steel.
C. Fabricator: Company specializing in performing the work of this section with minimum five years of documented experience.
D. Erector: Company specializing in performing the work of this section with minimum five years of documented experience.
E. Fabricator and Erector shall follow the AISC 341 Appendix Q “Quality Assurance Plan”.

PART 2 PRODUCTS

2.01 MATERIALS
A. Steel Angles and Plates: ASTM A36/A36M.
B. Steel W Shapes and Tees: ASTM A992/A992M.
C. Rolled Steel Structural Shapes: ASTM A992/A992M.
D. Steel Shapes, Plates, and Bars: ASTM A 242/A 242M high-strength, corrosion-resistant structural steel.
E. Steel Shapes, Plates, and Bars: ASTM A529/A529M high-strength, carbon-manganese structural steel, Grade 50.
F. Steel Plates and Bars: ASTM A572/A572M, Grade 50 (345) high-strength, columbium-vanadium steel.
G. Cold-Formed Structural Tubing: ASTM A500, Grade B.
H. Hot-Formed Structural Tubing: ASTM A501, seamless or welded.
I. Steel Bars: ASTM A108 Grades 1015 through 1020.
J. Steel Plate: ASTM A514/A514M.
K. Steel Sheet: ASTM A1011/A1011M, Designation SS, Grade 30 hot-rolled, or ASTM A1008/A1008M, Designation SS, Grade 30 cold-rolled.
M. Shear Stud Connectors: Made from ASTM A 108 Grade 1015 bars.
N. Structural Bolts, Nuts and Washers: Carbon steel, ASTM A307, Grade A galvanized to ASTM A 153/A 153M, Class C.
O. High-Strength Structural Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, medium carbon, galvanized.
P. High-Strength Structural Bolts: ASTM A490 (ASTM A490M), with matching ASTM A563 (ASTM A563M) nuts and ASTM F436 washers; Type 1 alloy steel.
Q. Unheaded Anchor Rods: ASTM F1554, Grade 36, plain, with matching ASTM A563 or A563M nuts and ASTM F436 Type 1 washers.
R. Headed Anchor Rods: ASTM F1554, Grade 36, straight, with matching ASTM A563 or A563M nuts and ASTM F436 Type 1 washers. Use setting templates with jamb nuts top and bottom as required.
S. Welding Materials: AWS D1.1; type required for materials being welded.
T. Sliding Bearing Plates: Teflon coated.
U. Grout: Non-shrink, non-metallic aggregate type, complying with ASTM C1107/C1107M and capable of developing a minimum compressive strength of 7,000 psi at 28 days.
V. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.
W. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION
A. Shop fabricate to greatest extent possible.
B. Space shear stud connectors as indicated.
C. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
D. Fabricate connections for bolt, nut, and washer connectors.
E. Develop required camber for members.
F. Cut, drill or punch standard bolt holes perpendicular to metal surfaces.

2.03 FINISH
A. Prepare structural component surfaces in accordance with SSPC SP 2.
B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted.
C. Leave structural steel members un-primed.
D. Galvanize structural steel members to comply with ASTM A123/A123M. Provide minimum 1.7 oz/sq ft galvanized coating.

2.04 SOURCE QUALITY CONTROL
A. Provide shop testing and analysis of structural steel as required in structural notes.
B. High-Strength Bolts: Provide testing and verification of shop-bolted connections in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
C. Welded Connections: Visually inspect all shop-welded connections and test using one of the following:
   1. Radiographic testing performed in accordance with ASTM E94.
   2. Ultrasonic testing performed in accordance with ASTM E164. Use for all Full Penetration welds.
   3. Liquid penetrant inspection performed in accordance with ASTM E165.
   4. Magnetic particle inspection performed in accordance with ASTM E709.
PART 3 EXECUTION

3.01 ERECTION
   A. Erect structural steel in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges".
   B. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.02 TOLERANCES
   A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
   B. Maximum Offset From True Alignment: 1/4 inch.

3.03 FIELD QUALITY CONTROL
   A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.
   B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
   C. Welded Connections: Visually inspect all field-welded connections and using one of the following:
      1. Radiographic testing performed in accordance with ASTM E94.
      2. Ultrasonic testing performed in accordance with ASTM E164. Use for all Full Penetration Welds.
      3. Liquid penetrant inspection performed in accordance with ASTM E165.
      4. Magnetic particle inspection performed in accordance with ASTM E709.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Open web steel joists and shear stud connectors, with bridging, attached seats and anchors.
B. Loose bearing members, such as plates or angles, and anchor bolts for site placement.
C. Supplementary framing for floor and roof openings greater than 18 inches.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 35 15, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured or processed within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture, product cost data.
C. Shop Drawings: Indicate standard designations, joist coding, configurations, sizes, spacings, cambers, locations of joists, joist leg extensions, bridging, connections, and attachments. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.
D. Welders’ Certificates

1.03 QUALITY ASSURANCE
A. Perform Work, including that for headers and other supplementary framing, in accordance with SJI Standard Specifications Load Tables and SJI Technical Digest No.9.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Transport, handle, store, and protect products to SJI requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Steel Joists:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS
A. Open Web Joists: SJI Type K Joists:
B. Open Web Joists: SJI Type LH Joists:
C. Open Web Joists: SJI Type DLH Joists:
D. Open Web Joists: SJI Joist Girders:
F. Shear Stud Connectors: Made from ASTM A 108 Grade 1015 bars.
G. Structural Steel For Supplementary Framing and Joist Leg Extensions: ASTM A 36/A 36M.
H. Welding Materials: AWS D1.1; type required for materials being welded.
J. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.
2.03 FABRICATION
   A. Frame special sized openings in joist web framing as required.
   B. Space stud shear connectors on top of top chords as required.

2.04 FINISH
   A. Shop prime joists as specified.
      1. Do not prime surfaces that will be fireproofed.
      2. Galvanize steel ledge angles.
      3. Leave other steel members unprimed.
   B. Prepare surfaces to be finished in accordance with SSPC-SP 2.
   C. Galvanizing: Provide minimum 1.7 oz/sq ft galvanized coating to ASTM A123/A123M requirements.

2.05 SOURCE QUALITY CONTROL
   A. Provide shop testing of steel components as indicated on structural drawings.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify existing conditions prior to beginning work.

3.02 ERECTION
   A. Erect joists with correct bearing on supports.
   B. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment.
   C. Coordinate the placement of anchors for securing loose bearing members furnished as part of the work of this section.
   D. After joist alignment and installation of framing, field weld joist seats to steel bearing surfaces.
   E. Position and field weld joist chord extensions and wall attachments as detailed.
   F. Install supplementary framing for floor and roof openings greater than 18 inches.
   G. Do not permit erection of decking until joists are braced bridged, and secured or until completion of erection and installation of permanent bridging and bracing.
   H. Do not field cut or alter structural members without approval of joist manufacturer.
   I. After erection, prime welds, damaged shop primer, damaged galvanizing, and surfaces not shop primed, except surfaces specified not to be primed.

3.03 TOLERANCES
   A. Maximum Variation From Plumb: 1/4 inch.
   B. Maximum Offset From True Alignment: 1/4 inch.

3.04 FIELD QUALITY CONTROL
   A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Roof deck.
B. Composite floor deck.
C. Bearing plates and angles.
D. Stud shear connectors.

1.02 REFERENCE STANDARDS
E. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society; 2008.
F. SDI (DM) - Publication No.31, Design Manual for Composite Decks, Form Decks, Roof Decks; Steel Deck Institute; 2007.
H. SSPC-Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II; Society for Protective Coatings; 1997 (Ed. 2004).

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
B. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 35 15, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured or processed within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture, product cost data.
C. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
D. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.
E. Certificates: Certify that products furnished meet or exceed specified requirements.
F. Submit manufacturer's installation instructions.
G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.04 QUALITY ASSURANCE
A. Installer Qualifications: Company specializing in performing the work of this Section with minimum three years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Cut plastic wrap to encourage ventilation.
B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Steel Deck:

2.02 STEEL DECK

A. All Deck Types: Select metal deck in accordance with SDI Design Manual.

B. Roof Deck: Non-composite type, fluted steel sheet:
   1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS), with G90/Z275 galvanized coating.
      a. Grade as required to meet performance criteria.
   2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
   3. Structural Properties:
   5. Nominal Height: As indicated.
   6. Profile: Fluted; SDI WR.
   7. Formed Sheet Width: As indicated.
   10. Fire Resistance Classification: Comply with UL Assembly Number _____, SERA?

C. Composite Floor Deck: Fluted steel sheet embossed to interlock with concrete:
   2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
   3. Structural Properties:
   5. Minimum Metal Thickness, Excluding Finish: As indicated.
   6. Nominal Height: As indicated.
   7. Profile: Fluted; SDI WR.
   8. Formed Sheet Width: As indicated.
   11. Fire Resistance Classification: Comply with UL Assembly Number _____, SERA?

2.03 ACCESSORY MATERIALS

A. Bearing Plates and Angles: ASTM A36/A36M steel, unfinished.

B. Stud Shear Connectors: Made from ASTM A 108 Grade 1015 bars.


D. Fasteners: Galvanized hardened steel, self tapping.

E. Weld Washers: Mild steel, uncoated, 3/4 inch outside diameter, 1/8 inch thick.

F. Shop and Touch-Up Primer: SSPC-Paint 25, zinc oxide, complying with VOC limitations of authorities having jurisdiction.

G. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, complying with VOC limitations of authorities having jurisdiction.

H. Flute Closures: Closed cell foam rubber, 1 inch thick; profiled to fit tight to the deck.

2.04 FABRICATED DECK ACCESSORIES

A. Sheet Metal Deck Accessories: Metal closure strips, wet concrete stops, and cover plates, 22 gage thick sheet steel; of profile and size as indicated; finished same as deck.

B. Cant Strips: Formed sheet steel, 20 gage thick, 45 degree slope, 3 1/2 inch nominal width and height, flange for attachment.
C. Roof Sump Pans: 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below roof deck surface, bearing flange 3 inches wide, sealed watertight.

D. Floor Drain Pans: 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below floor deck surface, bearing flange 3 inches wide, sealed watertight.

PART 3 EXECUTION

3.01 EXAMINATION

3.02 INSTALLATION

A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.

B. Clinch lock seam side laps.

C. At mechanically fastened male/female side laps fasten at 24 inches on center maximum.

D. At welded male/female side laps weld at 18 inches on center maximum.

E. Weld deck in accordance with AWS D1.3.

F. At deck openings from 6 inches to 18 inches in size, provide 2 x 2 x 1/4 inch steel angle reinforcement. Place angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and fusion weld to deck at each flute.

G. Where deck changes direction, install 6 inch minimum wide sheet steel cover plates, of same thickness as deck. Fusion weld 12 inches on center maximum.

H. At floor edges, install concrete stops upturned to top surface of slab, to contain wet concrete. Provide stops of sufficient strength to remain stationary without distortion.

I. At openings between deck and walls, columns, and openings, provide sheet steel closures and angle flashings to close openings.

J. Close openings above walls and partitions perpendicular to deck flutes with single row of foam cell closures.

K. Place metal cant strips in position and fusion weld.

L. Position roof drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.

M. Position floor drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.

N. Weld stud shear connectors through steel deck to structural members below.

O. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Formed steel stud exterior wall framing.
   B. Exterior wall sheathing.
   C. Formed steel joist framing and bridging.
   D. Water-resistant barrier over sheathing.

1.02 REFERENCE STANDARDS
   A. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)
   F. ASTM C955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases; 2011c.
   G. PS 1 - Structural Plywood; 2009.
   H. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on standard framing members; describe materials and finish.
      1. Provide manufacturer’s data on factory-made framing connectors, showing compliance with requirements.
   C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 35 15, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured or processed within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture, product cost data.
   D. Shop Drawings: Indicate framing layout, framed openings, bearing, anchorage, loading, welds and type and locations of fasteners, and accessories or items required of related work.
      1. Indicate stud and ceiling joist layout.
      2. Provide design engineer’s stamp on drawings.
   E. Manufacturer’s Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.
   B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience.
PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Metal Framing, Connectors, and Accessories:

2.02 FRAMING MATERIALS
   A. Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape; U-shaped track in matching nominal width and compatible height.
   B. Framing Connectors: Factory-made, formed steel sheet.
      1. Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for thicknesses less than 10 gage (0.118 inch), and factory punched holes and slots.

2.03 WALL SHEATHING
   A. Glass Mat Faced Gypsum Sheathing: ASTM C 1177/C 1177M, water-resistant core, square long edges; see Section 06 16 53.

2.04 ACCESSORIES
   A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
   B. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
   C. Water-Resistive Barrier: As specified in Section 07 25 00.

2.05 FASTENERS
   A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
   B. Anchorage Devices: Powder actuated.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION OF STUDS
   A. Install components in accordance with manufacturers' instructions and ASTM C 1007 requirements.

3.03 WALL SHEATHING
   A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.
      1. Place water-resistive barrier horizontally over wall sheathing, weather lapping edges and ends.

3.04 TOLERANCES
   A. Maximum Variation from True Position: 1/4 inch.
   B. Maximum Variation of any Member from Plane: 1/4 inch.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
A. Delegated design, load-bearing, thermally isolated, cold formed stainless steel furring assemblies for wall cladding systems listed in other sections.

1.02  QUALITY ASSURANCE
A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of the project.

1.03  SUBMITTALS
A. Product Data: For each type of product indicated.
B. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 35 15, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured or processed within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture, product cost data.

PART 2  PRODUCTS

2.01  PRODUCTS
A. Metal Framing, Connectors, Themally Broken Connectors, Fasteners, and Accessories:
   1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  FRAMING SYSTEM
A. Provide stainless steel (Galvanized steel G-185 at Penthouse furring) primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete, thermally broke, structurally designed framing system for support of several exterior cladding systems.
B. Design Criteria: Provide completed framing system having the following characteristics:
   1. Design: Calculate structural characteristics of cold-formed steel framing members according to AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
   2. Structural Performance: Design, engineer, fabricate, and erect to withstand specified design loads for project conditions within required limits (See Structural Notes).
   3. Design Loads: In accordance with applicable codes.
   4. Capable of withstanding vertical and horizontal assembly loads as required by cladding manufacturer per design criteria indicated in structural notes.
   5. Horizontal Deflection: Designed to permit maximum deflection of 1/720 of span.
   6. Vertical Deflection: Non-axial loadbearing framing designed to accommodate not less than 1/8 inch vertical deflection.
   7. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
   8. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.03  FRAMING MATERIALS
A. Studs and Track: ASTM C 955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
B. Framing Connectors: Factory-made formed steel sheet, type 304 stainless steel, and factory punched holes.
1. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold Formed Steel Structural Members; minimum 16 gage, 0.06 inch thickness.

2. Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.

### 2.04 WALL SHEATHING

A. Glass Mat Faced Gypsum Sheathing: ASTM C 1177/C 1177M, water-resistant core, square long edges, 1/2 inch thick, or 5/8 inch thick for rated conditions.

### 2.05 ACCESSORIES

A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

B. Water-Resistive Barrier: As specified in Section 07 25 00.

### 2.06 FASTENERS

A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers:
   1. Type 316 stainless steel, with corrosion resistance rating of 2000 hours salt spray resistance per ASTM B 117.

B. Anchorage Devices: Power actuated.

### PART 3 EXECUTION

### 3.01 INSTALLATION OF STUDS

A. Install components in accordance with manufacturers’ instructions, shop drawings, and ASTM C 1007 requirements.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Shop fabricated steel items.
   B. Prefabricated ladders and ship ladders.
   C. Manufactured metal items.

1.02 REFERENCE STANDARDS
   G. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2013.
   H. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010a.
   I. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.

1.03 DESIGN REQUIREMENTS
   A. Design and fabricate stair assembly to support a uniform live load of 100 lb/sq ft and a concentrated load of 300 lb with deflection of stringer or landing framing not to exceed 1/180 of span.
   B. Design railing assemblies, wall rails, and attachments to resist lateral force of 200 lbs at any point without damage or permanent set. Test in accordance with ASTM E 935.
   C. Design and fabrication of stairs and railings are at a minimum required to conform to NAAMM AMP 510 for metal stairs and AMP 521 for railings.
   D. Design and fabrication of railings in longer than 12 feet are required to meet more stringent requirements than industry standards to achieve a visual aesthetic straight line appearance and higher level of tolerance in joint smoothness without gaps.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
      1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   C. Samples: Manufactured units.
   D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.

E. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

1.05 QUALITY ASSURANCE

A. Design beams and railings under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Sections: ASTM A 36/A 36M.
B. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.
C. Plates: ASTM A 283.
E. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components.
F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
G. Shop Primer: Multi-purpose structural steel primer, complying with VOC limitations of authorities having jurisdiction.
1. Tnemec Series 394 Mio-Zinc filled polyurethane primer.
H. Touch-Up Primer for Galvanized Surfaces, Shop and Field: SSPC-Paint 20, Type II - Organic, complying with VOC limitations of authorities having jurisdiction.
1. Tnemec Series 135 Modified epoxy primer. Tint to match zinc.

2.02 MANUFACTURED UNITS

A. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3.
2. Material: Steel complying with ASTM A 1008/A 1008M, commercial steel, Type B; minimum thickness; []
3. Fasteners and Accessories: Designed for use and loads, same finish as channel.
4. Acceptable Manufacturer: Unistrut Corp.

2.03 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.
B. Fabricate items with joints tightly fitted and secured.
C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
2.04 FABRICATED ITEMS

A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; galvanized finish.
   1. Side Rails: 3/8 x 2 inches members spaced at 20 inches.
   2. Rungs: one inch diameter solid round bar spaced 12 inches on center.
   3. Space rungs 7 inches from wall surface.
B. Delegated Design Ships Ladders and Railings:
   1. Fabricate to detail from structural steel complying with referenced standards.
      a. Dimensions: As indicated on drawings.
         1) Width: 24 inches.
      b. Stringers: 10” structural channel.
      c. Treads: Heavy duty welded serrated bar grating treads with 12 inch center to center spacing; 1 x 1/8 inch bars at 1/2 inches on center with 4 inch cross bar centers.
      d. Railings: Welded handrails of 1 1/2” x 14 gage square tubing.
      e. Finish: Prime paint for field painted finish.
   2. Base and Top Mounting brackets and attachments; prime paint finish.
C. Delegated Design Railings: Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E 985 and applicable local code.
   1. Aesthetic Design Intent: As indicated.
   2. Material: Round structural steel pipe or tube complying with referenced standards.
   3. Jointing: Fully welded, Continuously welded and ground smooth, flush and straight without buldge or divet/flush.
   4. Dimensions: As indicated on drawings.
   5. Finish:
   6. Railing Conditions:
      a. Wall mounted handrails.
      b. Stair railings and guardrails.
      c. Free-standing railings at steps.
   7. Accessories: Per anchoring and securing requirements.
D. Sill Angles for Tempered Glass Railing Assemblies: ASTM A36/A36M steel angles with anchoring devices and sizes as indicated in shop drawings for railing assembly, drilled and tapped for fastener types, sizes, and spacing indicated, prime paint finish.
E. Metal Wall Base:
   1. Material: Stainless steel, ASTM A666 Type 304, 16 gauge; smooth No. 4 finish.
   2. Height: 2-inches.
   3. Profile: As indicated.
F. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.
G. Lintels: As detailed; galvanized finish.
H. Sill Angles for Tempered Glass Railing Assemblies: ASTM A36/A36M steel angles with anchoring devices and sizes as indicated in shop drawings for railing assembly, drilled and tapped for fastener types, sizes, and spacing indicated, prime paint finish.
I. Elevator Hoistway and Hoistway Divider Beams: Beam sections; prime paint finish.
J. Welded Heavy Duty Bar Grates with Anchored Embed Angle Frames:
   1. Elevator Pit Sump Grate: 1-1/4 x 1/4 inches 12 WH 4; galvanized finish.

2.05 FINISHES - STEEL

A. Prime paint all steel items.
   1. Exceptions: Galvanize items to be embedded in concrete or masonry and items specified for exterior exposure with no painted finish.
B. Prime Painting: One coat, 2.5 mils dry film thickness.
C. Steel items for exterior exposure are to receive surface preparation immediately prior to a high performance coating application, see Section 09 96 00.

2.06 FABRICATION TOLERANCES
   A. Squareness: 1/8 inch maximum difference in diagonal measurements.
   B. Maximum Offset Between Faces: 1/16 inch.
   C. Maximum Misalignment of Adjacent Members: 1/16 inch.
   D. Maximum Bow: 1/8 inch in 48 inches.
   E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION
   A. Clean and strip primed steel items to bare metal where site welding is required.
   B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION
   A. Install items plumb and level, accurately fitted, free from distortion or defects.
   B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
   C. Obtain approval prior to site cutting or making adjustments not scheduled.
   D. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES
   A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
   B. Maximum Offset From True Alignment: 1/4 inch.

3.05 SCHEDULE
   A. MB-1
      1. Location: Interior curtain wall corridor, conference, vestibule
      2. Product: 2 inch stainless steel wall base

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Delegated design stairs with concrete treads.
B. Delegated design stairs with precast concrete treads.
C. Structural steel stair framing and supports.
D. Handrails and guards.

1.02 REFERENCE STANDARDS

E. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2013.
F. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010a.
I. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.
K. Green Seal Standard GS-11, Paints.
L. Green Seal Standard GC-03, Anti-Corrosive Paints.
M. SCAQMD Rule 1113, Architectural Coatings

1.03 DESIGN REQUIREMENTS

A. Design and fabricate stair assembly to support a uniform live load of 100 lb/sq ft and a concentrated load of 300 lb with deflection of stringer or landing framing not to exceed 1/180 of span.
B. Design railing assemblies, wall rails, and attachments to resist lateral force of 200 lbs at any point without damage or permanent set. Test in accordance with ASTM E 935.
C. Design and fabrication of stairs and railings are at a minimum required to conform to NAAMM AMP 510 for metal stairs and AMP 521 for railings.
D. Design and fabrication of railings in longer than 12 feet are required to meet more stringent requirements than industry standards to achieve a visual aesthetic straight line appearance and higher level of tolerance in joint smoothness without gaps.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Include the design engineer’s stamp or seal on each sheet of shop drawings.
C. Delegated Design Data: As required by authorities having jurisdiction.

D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.

E. Welders' Certificates.

1.05 QUALITY ASSURANCE

A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
   1. Regulatory Requirements: Provide stairs and railings complying with the most stringent requirements of local, state, and federal regulations; where requirements of the contract documents exceed those of regulations, comply with the contract documents.
   2. Structural Design: Provide complete stair and railing assemblies complying with the applicable local code.
   3. At exit stairwells, provide unit stair towers designed for stacking to height of building as a self-supporting structure.
   4. Dimensions: As indicated on drawings.
   5. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
   6. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
   7. Separate dissimilar metals using paint or permanent tape.

B. Metal Jointing and Finish Quality Levels:
   1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
      a. Welded Joints: Continuously welded and ground smooth and flush.
      b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
      c. Exposed Edges and Corners: Eased to small uniform radius.
      d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
   2. Service: Exposed joints tight with face surfaces aligned; underside of stair not covered by soffit is not considered exposed to view.
      a. Welded Joints: Welded on back side wherever possible.
      b. Welds Exposed to View: Ground smooth; not required to be flush.
      c. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts or screw threads.
      d. Metal Surfaces to be Painted: Sanded smooth, suitable for satin or matte finish.

C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH PRECAST CONCRETE TREADS

A. Jointing and Finish Quality Level: Architectural, as defined above.
B. Risers: integral to thread, open.
C. Treads: Precast concrete, see Section 03 45 00.
   1. Concrete Depth: 1-1/2 inches, minimum as indicated.
   2. Concrete Reinforcement: Welded wire mesh.
   3. Concrete Finish: Steel troweled.
D. Risers: Same material and thickness as tread pans.
   1. Nosing Depth: Not more than 1 inch overhang.
   2. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch wide.
E. Stringers: Rolled steel channels.
   1. Stringer Depth: As indicated on drawings.
   2. End Closure: Sheet steel welded across ends.
F. Railings: Stainless Steel pipe railings.

2.03 METAL EXITING STAIRS WITH CONCRETE PAN TREADS

A. Jointing and Finish Quality Level: Service, as defined above.
B. Risers: Closed.
C. Treads: Metal pan with field-installed concrete fill.
   1. Concrete Depth: 1-1/2 inches, minimum.
   2. Tread Pan Material: Steel sheet.
   3. Tread Pan Thickness: As required by design; 14 gage, 0.075 inch minimum.
   5. Concrete Finish: Steel troweled.
D. Risers: Same material and thickness as tread pans.
   1. Nosing Depth: Not more than 1-1/2 inch overhang.
   2. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch wide.
E. Stringers: Rolled steel channels.
   1. Stringer Depth: 10 inches.
   2. End Closure: Sheet steel of same thickness as risers welded across ends.
F. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.
G. Railings: Steel pipe railings.
H. Finish: Shop- or factory-prime painted.

2.04 HANDRAILS AND GUARDS

A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
   1. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
   2. Material:
      a. Type 304 stainless steel typical.
      b. Schedule 40 steel pipe rails at enclosed exit stairs typical.
B. Guards:
   1. Top Rails: Round pipe or tube rails unless otherwise indicated.
      a. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
   2. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.
      a. Outside Diameter: 1 inch.
      b. Material: Steel pipe or tube, round.
      c. Vertical Spacing: Maximum 4 inches on center.
2.05 MATERIALS

A. Steel Sections: ASTM A 36/A 36M.
B. Steel Tubing: ASTM A500 or ASTM A501 structural tubing, round and shapes as indicated.
C. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.
D. Steel Plates: ASTM A 283.
E. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.
F. Ungalvanized Steel Sheet: ASTM A 1008/A 1008M, Designation SS, Grade 33, Type 1.
G. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/23/0 with G40/Z120 coating.
H. Concrete Reinforcement: Bar type as detailed, unfinished.
I. Steel Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
J. Welding Materials: AWS D1.1; type required for materials being welded.

2.06 SHOP FINISHING

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

2.07 COMPONENTS

A. Concrete: Type specified in Section 03300.

2.08 FABRICATION - GENERAL

A. Fit and shop assemble components in largest practical sections, for delivery to site.
B. Fabricate components with joints tightly fitted and secured.
C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
F. Fabricate components accurately for anchorage to each other and to building structure.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. When field welding is required, clean and strip primed steel items to bare metal.

3.03 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.
B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1.
E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
F. Obtain approval prior to site cutting or creating adjustments not scheduled.
G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES
A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Railing and guardrail assemblies.
B. Wall-mounted handrails.
C. Free-standing railings at steps.

1.02 REFERENCE STANDARDS
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
K. AWS D1.6 - Structural Welding Code - Stainless Steel; 1999.
L. Green Seal Standard GS-11, Paints.
M. Green Seal Standard GC-03, Anti-Corrosive Paints.
N. SCAQMD Rule 1113, Architectural Coatings

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturer's product data including description of materials, components, finishes, fabrication details, glass, anchors, and accessories.
C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
D. Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, brazed connections, transitions, and terminations.
E. Test Reports: Submit test reports from an independent testing agency showing compliance with specified design and performance requirements.
1.04 QUALITY ASSURANCE
A. Installer Qualifications: Company specializing in installing glazed railing systems and acceptable to manufacturer.
B. Installer Qualifications: Manufacturer of railing.
C. Mock-ups: Construct a railing of each type specified. Locate mock-ups where directed. Mockups may remain as part of the work.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver railing materials in factory provided protective coverings and packaging.
B. Protect railing materials against damage during transit, delivery, storage, and installation at site.
C. Inspect railing materials upon delivery for damage. Repair damage to be indistinguishable from undamaged areas; if damage cannot be repaired to be indistinguishable from undamaged parts and finishes, replace damaged items.
D. Prior to installation, store materials and components under cover, in a dry location.

1.06 FIELD CONDITIONS
A. Do not install railings until project is enclosed and ambient temperature of space is minimum 65 degrees F and maximum 95 degrees F.
B. Maintain ambient temperature of space at minimum 65 degrees F and maximum 95 degrees F for 24 hours before, during, and after railing installation.

1.07 WARRANTY
A. Warranty: Manufacturer's standard one year warranty against defects in materials, fabrication, finishes, and installation commencing on Date of Substantial Completion.

PART 2 PRODUCTS
2.01 RAILING SYSTEMS
A. Railings - General: Factory- or shop-fabricated in design indicated, to suit specific project conditions, and for proper connection to building structure, and in largest practical sizes for delivery to site.
1. Design Criteria: Design and fabricate railings and anchorages to resist the following loads without failure, damage, or permanent set; loads do not need to be applied simultaneously.
   a. Lateral Force: 75 lb minimum, at any point, when tested in accordance with ASTM E935.
   b. Distributed Load: 50 pounds per foot minimum, applied in any direction at the top of the handrail, when tested in accordance with ASTM E935.
   c. Concentrated Loads on Intermediate Rails: 50 pounds per square ft, minimum.
   d. Concentrated Load: 200 pounds minimum, applied in any direction at any point along the handrail system, when tested in accordance with ASTM E935.
2. Assembly: Join lengths, seal open ends, and conceal exposed mounting bolts and nuts using slip-on non-weld mechanical fittings, flanges, escutcheons, and wall brackets.
4. Field Connections: Provide sleeves to accommodate site assembly and installation.
5. Welded and Brazed Joints: Make exposed joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.
   a. Ease exposed edges to small uniform radius.
   b. Welded Joints:
      1) Carbon Steel: Perform welding in accordance with AWS D 1.1/D1.1M.
2) Stainless Steel: Perform welding in accordance with AWS D 1.6.

c. Brass/Bronze Brazed Joints:
   1) Perform torch brazing in accordance with AWS C3.4/3.4M.
   2) Perform induction brazing in accordance with AWS C3.5/3.5M.
   3) Perform resistance brazing in accordance with AWS C3.9/3.9M

B. Base Mount Railing System: Engineered, base supported railing system with structural glass.
   1. Top Cap: 1 by 1-1/2 inch stainless steel; No. 4 satin finish.
   2. Base Shoe, Aluminum: ASTM B221, 6063 T5 alloy, rectangular profile, natural anodized finish with isolator.
      a. Morse Industries Panel Grip Shoe, or approved equal.
   3. Base Cladding:
      a. Material: 18 gage, (0.05 inch) stainless steel; No. 4 satin finish.
   4. Glass: As specified in this section.
   5. Fasteners:
      a. Attachment to Concrete:
         1) Provide anchors capable of sustaining, without failure, a load equal to four times the load imposed when installed in concrete, tested in accordance with ASTM E488.
         2) Provide 12 inch center-to-center hole spacing; 1/2 by 4 inch concrete anchors.

C. Cable Railing System:
   1. Description: Post and cable railing system.
   2. Stainless Steel Tube: Type 304 stainless steel.
      a. Guardrail Post: Steel bar stock, as indicated
      b. Handrail: 1-1/2 inch outside diameter.
      c. Top Rail: Steel flat bar, as indicated
   3. Cable: ASTM A555/555M.
      a. Fabricate from ASTM A666 stainless steel, Type 304.
      b. Size: 3/16 inch diameter.
   4. Fittings: Type 304 stainless steel, non-swedge.
   5. Fasteners: Stainless steel.
   6. Finishes:
      a. Stainless Steel Handrail and Cable: No. 4 satin finish.
      b. Steel Guardrail Frame: Painted, see Section 09 90 00.
   7. Fabrication:
      a. Corners: Mitered and welded; grind smooth to match adjacent finish.
      b. Exposed Joints: Butt tight and flush.
      c. Splices: Provide interior sleeves; fasteners allowed at splice connections.

D. Wall/Floor-Mounted Handrail:
   1. 1-1/2 inch diameter stainless steel; No. 4 satin finish.
   2. Internal Connection Sleeves: Sleeve, material compatible with handrail and top cap material.
   3. Handrail Brackets: Manufacturer's standard stainless steel brackets.

2.02 MATERIALS
A. Steel Guardrail Frame Components:
   1. ASTM A36/A36M.
   2. Sizes: As indicated.
   3. Finish: Primed and painted - see Section 09 90 00.

B. Stainless Steel Components:
   1. ASTM A666, Type 304.
   2. Stainless Steel Tubing: 16 gage (0.0625 inch), 1-1/2 inch diameter.
   3. Stainless Steel Finish: No. 4 Satin.
4. Surface Mounted LED handrail LED STN STL Renovation and New Construction Package
   IO Lighting 0-06-SSP-2-WM-NR-66-35K-xx-xx-DRV

C. Glass: Laminated safety glass; ASTM C 1172, unless otherwise indicated.
   1. Plastic Interlayer: Minimum 0.060 inch thick.
   2. Impact Strength: Category II, tested in accordance with 16 CFR 1201.
   3. Thickness: 1/2 inch.
   4. Configuration: As indicated on drawings.
   5. Edges: Ground smooth and polished.

D. Wood Guardrail Cap:

2.03 ACCESSORIES

A. Welding Fittings: Factory- or shop-welded from matching pipe or tube; joints and seams
   ground smooth.

B. Anchors and Fasteners: Provide anchors and other materials as required to attach to structure,
   made of same materials as railing components unless otherwise indicated; where exposed
   fasteners are unavoidable provide flush countersunk fasteners.
   1. For anchorage to concrete, provide inserts to be cast into concrete for bolting anchors.
   2. For anchorage to masonry, provide brackets to be embedded in masonry for bolting
      anchors.
   3. For anchorage to stud walls, provide backing plates for bolting anchors.
   4. Exposed Fasteners: No exposed bolts or screws.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate and site conditions are acceptable and ready to receive work.
B. Verify field dimensions of locations and areas to receive work.
C. Notify Architect immediately of conditions that would prevent satisfactory installation.
D. Do not proceed with work until detrimental conditions have been corrected.
E. Furnish components to be installed in other work to installer of that other work, including but not
   limited to blocking, sleeves, inserts, anchor bolts, embedded plates and supports for
   attachment of anchors.

3.02 PREPARATION

A. Review installation drawings before beginning installation. Coordinate diagrams, templates,
   instructions and directions for installation of anchorages and fasteners.
B. Clean surfaces to receive units. Remove materials and substances detrimental to the
   installation.

3.03 INSTALLATION

A. Comply with manufacturer's drawings and written instructions.
B. Install components plumb and level, accurately fitted, free from distortion or defects and with
   tight joints, except where necessary for expansion.
C. Anchor securely to structure.
D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush
   countersunk fastenings.
E. Isolate dissimilar materials with bituminous coating, bushings, grommets or washers to prevent
   electrolytic corrosion.
3.04 TOLERANCES
   A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.
   B. Maximum Offset From True Alignment: 1/4 inch.

3.05 FIELD QUALITY CONTROL
   A. Field Services: Provide the services of the manufacturer for field observation of installation of railings.

3.06 CLEANING
   A. Remove protective film from exposed metal surfaces.
   B. Metal: Clean exposed metal finishes with potable water and mild detergent, in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents or other substances that may damage the material or finish.
   C. Glass and Glazing: Clean glazing surfaces; remove excess glazing sealant compounds, dirt, and other substances.

3.07 PROTECTION
   A. Protect installed components and finishes from damage after installation.
   B. Repair damage to exposed finishes to be indistinguishable from undamaged areas.
      1. If damage to finishes and components cannot be repaired to be indistinguishable from undamaged finishes and components, replace damaged items.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Exposed timber structural framing.
B. Rough opening framing for doors, windows, and roof openings.
C. Underlayment.
D. Preservative treated wood materials.
E. Fire retardant treated wood materials.
F. Miscellaneous framing and sheathing.
G. Communications and electrical room mounting boards.
H. Concealed wood blocking, nails, and supports.
I. Miscellaneous wood nailers, furring, and grounds.

1.02 REFERENCE STANDARDS
D. PS 1 - Structural Plywood; 2009.
F. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology, Department of Commerce; 2010.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.
C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   4. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   5. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
D. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.04 QUALITY ASSURANCE
A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
B. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

1.05 DELIVERY, STORAGE, AND HANDLING
A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS
2.01 GENERAL REQUIREMENTS
A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
   2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
B. Lumber fabricated from old growth timber is not permitted.
C. Provide sustainably harvested wood and harvested within a 500 mile radius of the project site.

2.02 DIMENSION LUMBER
A. Sizes: Nominal sizes as indicated on drawings, S4S.
B. Moisture Content: S-dry or MC19.
C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
   1. Lumber: S4S, No. 2 or Standard Grade.
   2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS
A. Subflooring: Any PS 2 type, rated Sheathing.
   3. Performance Category: 3/4 PERF CAT.
B. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
C. Other Applications:
   1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
   2. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
   3. Other Locations: PS 1, C-D Plugged or better.

2.04 ACCESSORIES
A. Sill Gasket on Top of Foundation Wall: 1/4 inch thick, plate width, closed cell plastic foam from continuous rolls. Provide Weathermate Sill Seal Foam Gasket manufactured by DOW Corporation; dow.com, or FoamSealR Sill Plate Gasket, manufactured by Owens Corning; www.owenscorning.com.
B. Subfloor Glue: Waterproof, water base, air cure type, cartridge dispensed.
2.05 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
   1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
   2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Fire Retardant Treatment:
   1. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
      a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
      b. Do not use treated wood in direct contact with the ground.
   2. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
      a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
      b. Treat rough carpentry items as indicated.
      c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

C. Preservative Treatment:

D. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.
   1. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
   2. Treat lumber in contact with roofing, flashing, or waterproofing.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.
B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.02 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to code authorities may be used in lieu of solid wood blocking.
C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

F. Specifically, provide the following non-structural framing and blocking:

G. Subject to compliance with requirements, provide the following non-structural framing and blocking that may be incorporated into the Work include, but are not limited to, the following:
   1. Cabinets and shelf supports.
   2. Wall brackets.
   3. Handrails.
   4. Grab bars.
   5. Towel and bath accessories.
   6. Wall-mounted door stops.
   7. Chalkboards and marker boards.
   8. Wall paneling and trim.
   9. Joints of rigid wall coverings that occur between studs.

3.03 INSTALLATION OF CONSTRUCTION PANELS

A. Subflooring: Glue and nail to framing; staples are not permitted.

B. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
   1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
   2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
   3. Install adjacent boards without gaps.

3.04 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.

B. Allow preservative to dry prior to erecting members.

3.05 TOLERANCES

A. Framing Members: 1/4 inch from true position, maximum.

B. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Plywood structural wood decking.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide technical data on wood preservative materials.
C. Shop Drawings: Indicate deck framing layout.
D. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit MR 2: Waste Material Tracking Form, Section 01 74 19.
   3. Credit MR 5: (Regional) Straight-line distance to Manufacturer and distance to material extraction for each product. If greater than 500 miles, report “> 500”. Product cost data.
   5. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   6. Credit EQ 4.2: Manufacturers' product data for paints, including printed statement of VOC content and statement concerning list of prohibited chemicals.
   7. Credit EQ 4.4: Composite wood manufacturer's product data for each composite wood product used indicating that bonding agent used contains no urea formaldehyde.

1.03 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience and certified by AITC.
B. Installer: Company specializing in performing work of the type specified in this section with minimum three years of experience.

1.04 REGULATORY REQUIREMENTS
A. Conform to applicable code for fire retardant requirements.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Protect glue laminated members in accordance with AITC 111 requirements for unwrapped material.

PART 2 PRODUCTS

2.01 WOOD MATERIALS
A. Wood fabricated from old growth timber is not permitted.
B. Plywood Decking: PS 1 veneer plywood; APA Rated Sheathing, Span Rating 32/16; Exterior grade; 1 A interior veneer appearance grade; sanded.
C. Architectural Grade Tongue and Groove Decking: FSC Certified Douglas-Fir Select Dex or approved equal. Decking sizes indicated on structural drawings.

2.02 ACCESSORIES
A. Fasteners and Anchors:
   1. Fastener Type and Finish: Hot-dipped galvanized steel for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
   2. See Structural Notes

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that support framing is ready to receive decking.
3.02 PREPARATION
   A. Coordinate placement of bearing items.

3.03 INSTALLATION - PLYWOOD DECKING
   A. Install decking perpendicular to framing members, with ends staggered over firm bearing. On
      sloped surfaces, lay decking with tongue upward.
   B. Engage plywood tongue and groove edges.
   C. Allow expansion space at edges and ends.

3.04 TOLERANCES
   A. Surface Flatness of Decking Without Load: 1/4 inch in 10 feet maximum, and 1/2 inch in 30 feet
      maximum.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Moisture resistant wall sheathing fire-rated.
B. Structural moisture resistant wall sheathing fire-rated.
C. Accessories.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's technical data on sheathing product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
C. Manufacturer's Certificate: Certify that products supplied meet or exceed specified requirements.
D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.

1.03 DELIVERY, STORAGE, AND HANDLING

A. General: Cover products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Gypsum Sheathing Type X Fire-Rated:
   1. Georgia-Pacific; www.gpgypsum.com
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Structural Gypsum Sheathing:
   1. Sure-Board Series 200 Type X Fire-Rated:
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Sheathing: Glass mat faced gypsum, ASTM C 1177C/1177M, Type X fire-resistant core, long edges.
   1. Fire Resistance:
      a. Dens-Glass Gold Fireguard: One hour rated systems when tested in accordance with ASTM E 119, UL Classified.
      b. If roofing manufacturer will not warrant the roof system with Dens-Glass Gold, provide manufacturer's approved sheathing where interfacing with roofing system.
      c. Sheathing must also be rated to conform to roofing installation requirements including roofing temperature required for hot application roofing.
2. Thickness: 5/8 inch for rated assemblies.
3. Edges: Square.

2.03 ACCESSORIES
A. Fasteners and Anchors:
B. Self-Adhered Membrane Weather Barriers: See Section 07 25 09.
C. Self-Adhered Membrane Flashing: See Section 07 25 11.
   1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
E. Sealant: Manufacturer's Silicone Sealant; gunnable silicone.

PART 3 EXECUTION
3.01 EXAMINATION
A. Do not begin installation until framing is complete and properly prepared.
B. If framing is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION
A. Wall: Sheathing: Install in accordance with manufacturer's instructions and building code.
B. Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.
C. Gypsum Sheathing Fastening: Screw to steel studs and runners with bugle head screws spaced, sized, and located as required by building code.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
A. Glue laminated wood beams and purlins.
B. Steel hardware and attachment brackets.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide technical data on wood preservative materials, application technique
   and resultant performance information.
C. Shop Drawings: Indicate framing system, sizes and spacing of members, loads and cambers,
   bearing and anchor details, bridging and bracing, framed openings.
D. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following
   Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit MR 2: Waste Material Tracking Form, Section 01 74 19.
   2. Credit MR 4: Recycled content for each product, post-consumer and post-industrial.
      Product cost data.
   3. Credit MR 5: (Regional) Straight-line distance to Manufacturer and distance to material
      extraction for each product. If greater than 500 miles, report “> 500”. Product cost data.
   5. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed
      statement of VOC content.

1.03 QUALITY ASSURANCE
A. Manufacturer/Fabricator Qualifications: Company specializing in manufacture of glue laminated
   structural units with three years of documented experience, and certified by AITC in
   accordance with AITC A190.1.
B. Erector Qualifications: Company specializing in erection of products of the type specified, with
   three years of experience.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Protect members to AITC requirements for not wrapped.
B. Leave individual wrapping in place until finishing occurs.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Glued-Laminated Structural Units:
   4. Rosboro: www.rosboro.com
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GLUED-LAMINATED UNITS
A. Glued-Laminated Units: Fabricate in accordance with AITC 117 Architectural grade.
   1. Verify dimensions and site conditions prior to fabrication.
   2. Cut and fit members accurately to length to achieve tight joint fit.
   3. Fabricate member with camber built in.
   4. Do not splice or join members in locations other than those indicated without permission.
   5. After end trimming, seal with penetrating sealer in accordance with AITC requirements.

2.03 MATERIALS
A. Lumber: Softwood lumber conforming to RIS grading rules with 12 percent maximum moisture
   content before fabrication. Design for values indicated on structural drawings. Provide FSC
   Architectural grade materials.
B. Steel Connections and Brackets: ASTM A36/A36M weldable quality, galvanize per ASTM A123/A123M.

C. Hardware: ASTM A325/A325M Type 1 high strength heavy hex bolts and ASTM A563/A563M nuts, with matching washers.
   1. Provide hardware to detail indicated; see Structural requirements.
   2. Finish: Custom color; See Section 09 90 00.

2.04 FABRICATION
   A. Fabricate glue laminated structural members in accordance with AITC Architectural grade.
   B. Welding: Perform welding in accordance with AWS D1.1.
   C. Verify dimensions and site conditions prior to fabrication.
   D. Cut and fit members accurately to length to achieve tight joint fit.
   E. Fabricate steel hardware and connections with joints neatly fitted, welded, and ground smooth.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that supports are ready to receive units.
   B. Verify sufficient end bearing area.

3.02 PREPARATION
   A. Coordinate placement of bearing items.

3.03 ERECTION
   A. Lift members using protective straps to prevent visible damage.
   B. Set structural members level and plumb, in correct positions or sloped where indicated.
   C. Provide temporary bracing and anchorage to hold members in place until permanently secured.
   D. Fit members together accurately without trimming, cutting, splicing, or other unauthorized modification.
   E. Countersink bolts flush with beam surface at areas indicate.
   F. Dap beams for connection plates where indicated or as required to accurately fit structural connectors to beams.
   G. Swab and seal the interior wood surfaces of field drilled holes and dapped areas of members with sealer.

3.04 PROTECTION
   A. Protect installed products from wet conditions at all times until cover by structure.

3.05 TOLERANCES
   A. Framing Members: 1/2 inch maximum from true position.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Finish carpentry items.
B. Wood door frames, glazed frames.
C. Wood casings and moldings.
D. Hardware and attachment accessories.

1.02  RELATED REQUIREMENTS

A. Section 09 90 00 - Painting and Coating: Painting and finishing of finish carpentry items.

1.03  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data:
   1. Provide data on fire retardant treatment materials and application instructions.
   2. Provide instructions for attachment hardware and finish hardware.
C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Provide the information required by AWI/AWMAC/WI Architectural Woodwork Standards.
D. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, accessories, to a minimum scale of 1-1/2 inch to 1 ft.
E. Samples: Submit two samples of wood trim 18 long.
F. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit MR 3: Salvaged, refurbished or reused materials; product cost data.
   3. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   5. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   6. Credit EQ 4.2: Manufacturers’ product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.

1.04  QUALITY ASSURANCE

A. Perform work in accordance with AWI Architectural Woodwork Quality Standards Illustrated, Custom grade.
B. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.05  REGULATORY REQUIREMENTS

A. Conform to applicable code for fire retardant requirements.

1.06  DELIVERY, STORAGE, AND HANDLING

A. Protect work from moisture damage.

1.07  PROJECT CONDITIONS

A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS
A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI/AWMAC/WI Architectural Woodwork Standards for Custom Grade.

2.02 WOOD-BASED COMPONENTS
A. Wood fabricated from old growth timber is not permitted.

2.03 STANDING AND RUNNING TRIM LUMBER MATERIALS
A. Wood base as scheduled
   1. Hardwood and/or Softwood solid lumber. Maximum moisture content of 6 percent.
   2. Species as indicated. Plain sawn, with flat grain of quality suitable for painted finish.

2.04 WOOD DOOR AND RELIGHT FRAMES
A. Door and Relight Frames:
   1. Door Frames to match door face species and finish unless indicated otherwise.
   2. Hardwood and/or Softwood solid lumber. Maximum moisture content of 6 percent.
   3. Species as indicated. Plain sawn, with flat grain of quality suitable for painted finish.

2.05 LUMBER MATERIALS
A. Softwood Lumber: Reclaimed lumber milled to detailed sizes indicated, see schedule at end of this section.
   1. Glulams: Resawn and machine plane to indicated sizes, select visible best side for exposure, overdrill and plug bolt holes, glue and doweled end joint splices for consistent smooth flush connection.
      a. Glulam treads and risers.
      b. Glulam curtainwall screen.
      c.
   2. Reclaimed Fir Ceilings:
      a. Sand smooth and flat for one exposed side suitable for clear finish.
      b. Miter lap end joints, concealed fasteners.
   3. Solid Wood Fir Panels:
      a. Shop fabricated.
      b. Location: Student Street.
      c. Finish: Clear.

B. Hardwood Lumber:
   1. Standing and Running Trim: Closed grain hardwood of any species suitable for a paint grade finish.
   2. Select Trim Elements: Reclaimed white oak milled to specified AWS grade, suitable for clear finish.
   3. Areas Indicated: FSC Certified Black Locust solid wood boards, pre-weathered gray/silver.

2.06 SHEET MATERIALS
A. MDF: Medium Density Fiberboard complying with ANSI/AHA A208.2, Class MD, no added formaldehyde.
   1. SierraPine Medite II or approved comparable product.
B. MDFX: Medium Density Fiberboard, Exterior Grade, complying with ANSI/AHA A208.2, Class MD-exterior, formaldehyde-free.
   1. SierraPine Medex or approved comparable product.
C. Softwood Plywood Not Exposed to View: Any face species, veneer core; PS 1 Grade A-B; glue type as recommended for application.
D. Hardwood Plywood: Face species as indicated, plain sawn, book matched, medium density fiberboard core; HPVA HP-1, Front Face Grade A, Back Face Grade 1; glue type as recommended for application.

2.07 FASTENINGS
A. Adhesive for Purposes Other Than Laminate Installation: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.
B. Fasteners: Of size and type to suit application.
C. Sealant: Of type to suit application.

2.08 ACCESSORIES
B. Primer: as specified in Section 09 90 00.
C. Wood Filler: Water base, tinted to match surface finish color.

2.09 HARDWARE
A. Hardware: Comply with BHMA A156.9.

2.10 FABRICATION
A. Shop assemble work for delivery to site, permitting passage through building openings.
B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify adequacy of backing and support framing.
B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION
A. Install work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards requirements for grade indicated.
B. Set and secure materials and components in place, plumb and level.
C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.

3.03 PREPARATION FOR SITE FINISHING
A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
B. Site Finishing: See Section 09 90 00.
C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.
D. Finish preparatory materials shall be EQ 4.1 and 4.2 VOC compliant.

3.04 TOLERANCES
A. Maximum Variation from True Position: 1/16 inch.
B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

3.05 SCHEDULE
A. UPH-1A
   1. Location: Student Street
   2. Manufacturer: Buzzi Space
   3. Product: Buzzie Skin
   4. Application: Tackable Wall Panel
   5. Color: Stonegrey 67
B. UPH-1B: Not used.

C. UPH-2
1. Location: Student Street Level 1
2. Manufacturer: Designtex
3. Product: Inlet 3426-501
4. Application: Built-in upholstered booth seating, seat
5. Color: Parsley

D. UPH-3
1. Location: Student Street Level 1
2. Manufacturer: Designtex
3. Product: Pigment 2711-510
4. Application: Built-in upholstered booth seating, back

E. UPH-4
1. Location: Student Street Level 2
2. Manufacturer: Wolf Gordon
3. Product: Ansonia G9035852
4. Application: Built-in upholstered booth seating, seat
5. Color: Guacamole

F. UPH-5
1. Location: Student Street Level 2
2. Manufacturer: Designtex
3. Product: Lolland 3263-501
4. Application: Built-in upholstered booth seating, seat
5. Color: Lichen Light

G. UPH-6: Not used.

H. UPH-7
1. Location: "O" Lounge
2. Manufacturer: Designtex
3. Product: Tessellate 3379-801
4. Application: Built-in upholstered booth seating, back
5. Color: Tuxedo

I. UPH-8
1. Location: EMU Lobby
2. Manufacturer: Maharam
3. Product: Ledger 463770
4. Application: Built-in upholstered booth seating, seat
5. Color: 004 Mineral

J. UPH-9
1. Location: EMU Lobby
2. Manufacturer: Pollack
3. Product: Do Si Do
4. Application: Built-in upholstered booth seating, back
5. Color: 4167/03 Pebble

K. UPH-10
1. Location: Fountain Court/Nest
2. Manufacturer: Designtex
3. Product: Faux Sure 28810-802
4. Application: Built-in upholstered booth seating, seat
5. Color: Charcoal

L. UPH-11
1. Location: Fountain Court/Nest
2. Manufacturer: Architex
3. Product: Waistcoat
4. Application: Built-in upholstered booth seating, back
5. Color: Dakota

M. UPH-12: Not used.
N. UPH-13: Not used.
O. UPH-14: Not used.

P. R-WD-1
1. Location: Hearth
2. Product: Reclaimed interior glulam rails
3. Application: Seating stair tread and risers
4. Mill Surfacing: Resawn to sizes and sanded smooth
5. Finish: Translucent

Q. R-WD-2
1. Location: Hearth
2. Product: Reclaimed interior glulam rails
3. Application: Curtain wall screen
4. Mill Surfacing: Resawn to sizes and sanded smooth
5. Finish: Translucent

R. R-WD-3
1. Location: Student Street
2. Product: Reclaimed interior glulam rails
3. Application: Window trim
4. Mill Surfacing: Resawn to sizes and sanded smooth
5. Finish: Translucent

S. R-WD-4: Not used.

T. R-WD-5
1. Location: Varies
2. Product: Reclaimed interior ceiling panels
3. Application: Wall cladding
4. Mill Surfacing: Resawn to sizes and sanded smooth
5. Finish: Translucent

U. R-WD-6
1. Location: TBD
2. Product: Reclaimed from UO stockpile
3. Application: Wall Cladding
4. Mill Surfacing: Resawn to sizes and sanded smooth
5. Finish: Translucent

V. R-WD-7
1. Location: Varies
2. Product: Purchased reclaimed - Pioneer Millworks
3. Application: White oak trim/casework elements
4. Size: As indicated
5. Finish: Applied finish

W. R-WD-8
1. Location: South Canopy
2. Product: Tight-knot 5/4 kiln dried boards (Douglas Fir or Western Red Cedar).
3. Application: Canopy soffits.
4. Size: As indicated
5. Finish: Applied finish
X. R-WD-9  
1. Location: South Student Street and Hearth  
2. Product: 5/4 boards, pre-weathered to silver/gray  
4. Size: As indicated  
5. Finish: Applied finish  

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES
A. HPDL laminated cabinets.
B. MDF cabinets.
C. Cabinet hardware.
D. Countertops of the following types:
   1. HPDL laminated.
E. Wall shelving and standards.
F. Shop finishing.
G. Coordinate selection of lumber and wood veneer for transparent finish with the following:
   1. Section 06 20 00 - Finish Carpentry.
   2. Section 06 42 16 - Wood-Veneer Paneling.

1.02 SUBMITTALS
A. Product data for each type of product and process specified in this section and incorporated into items of architectural woodwork during fabrication, finishing, and installation.
B. Shop drawings showing location of each item, including dimensioned plans and elevations, large-scale details, attachment devices, and other components. Show materials, laminate colors, sinks, fittings, hardware, and other accessories. Show sink centerlines. Show locations of steel counter support locations, access panel locations, and Owner furnished under counter key board and mouse supports.
C. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit MR 2: Waste Material Tracking Form, Section 01 74 19.
   3. Credit MR 5: (Regional) Straight-line distance to Manufacturer and distance to material extraction for each product. If greater than 500 miles, report “> 500”. Product cost data.
   5. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   6. Credit EQ 4.2: Manufacturers’ product data for paints, including printed statement of VOC content and statement concerning list of prohibited chemicals.
   7. Credit EQ 4.4: Composite wood manufacturer’s product data for each composite wood product used indicating that bonding agent used contains no urea formaldehyde.
D. Samples for verification purposes of the following:
   1. Panel 18 inches by 18 inches with edge, finished, each laminate.
   2. Each exposed hardware item.
   3. Drawer guide and door hinge.
E. Qualification data for firms and persons specified in “Quality Assurance” article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

1.03 QUALITY ASSURANCE
   2. Shop Finish: Section 5. Grade specified in Part 2.
B. Installer: Employee of Manufacturer or subcontracted to Manufacturer.
C. Solid Surfacing Fabricator: Trained and certified by solid surfacing manufacturer.
D. Stone Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate stone countertops similar to that indicated for this Project and whose products have a record of successful in-service performance.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Protect woodwork during transit, delivery, storage, and handling to prevent damage, soiling, and deterioration.
B. Do not deliver woodwork until painting, wet work, grinding, and similar operations that could damage, soil, or deteriorate woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in "Project Conditions."

1.05 PROJECT CONDITIONS
A. Environmental Conditions: Obtain and comply with Woodwork Manufacturer's and Installer's coordinated advice for optimum temperature and humidity conditions for woodwork during its storage and installation. Do not install woodwork until these conditions have been attained and stabilized so that woodwork is within plus or minus 1.0 percent of optimum moisture content from date of installation through remainder of construction period.
B. Field Measurements: Where woodwork is indicated to be fitted to other construction, check actual dimensions of other construction by accurate field measurements before manufacturing woodwork; show recorded measurements on final shop drawings. Coordinate manufacturing schedule with construction progress to avoid delay of work.
   1. Verify locations of concealed framing, blocking, reinforcements, and furring that support woodwork by accurate field measurements before being enclosed. Record measurements on final shop drawings.
   2. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with manufacture of woodwork without field measurements. Provide allowance for trimming at site and coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.06 WARRANTY
A. Manufacturer's warranty against warpage, delamination, hardware failures, fasteners failures.
B. Warranty Period: 5 years
   1. Repair or replace product, Owner's option.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Custom Cabinet Shop, Member of AWI or WI.
   1. Not less than 10 years experience and complete knowledge of AWI standards.

2.02 EXISTING MATERIALS
A. List of salvaged materials or units that will be reused.

2.03 MATERIALS
A. General: Provide materials that comply with reference standard and specified requirements.
B. Formaldehyde Free: Provide composite wood products with no added formaldehyde, made without urea-formaldehyde adhesives or binders.
C. Lumber: Douglas fir, Quarter sawn.
D. Wood Veneer: Red alder, Quarter sliced.
   1. HPVA Grade A
   2. FSC certified.
E. Particleboard: ANSI A208.1 Grade M-2, moisture resistant.
F. Medium Density Fiberboard (MDF): ANSI/AHA A208.2, Class MD, formaldehyde-free.
ARCHITECTURAL WOOD CASEWORK

1. 100% recycled fiber.
2. Flakeboard Terra
3. SierraPine Medite FR
4. Roseburg SkyBlend MDF

   1. 100% recycled fiber.
   2. Flakeboard VESTEX
   3. SierraPine Medex

H. Softwood Plywood: PS 1, APA shop grade except APA Marine MDO where “Marine” is indicated.
   1. No added Formaldehyde.
   2. FSC certified.

I. Hardboard: ANSI/AHA A135.4

J. HPDL, High Pressure Decorative Laminate: NEMA LD 3 and the following patterns and colors:
   1. PLAM-1: See Schedule at end of Part 3.
   3. PLAM-3: See Schedule at end of Part 3.

2.04 HARDWARE AND ACCESSORIES

A. Hardware Quality: ANSI/BHMA A156.9, Grade 1

B. Hardware Finishes: ANSI/BHMA A156.18 for BHMA code number indicated.
   1. Oil Rubbed Bronze: BHMA 613.

C. Standard Door and Drawer Pulls: through bolted from back side; wire type, 4" center to center, 1-3/16" projection, 5/16" diameter, no escutcheons.

D. Concealed Hinge for Flush Overly: European style, steel, self-closing, 170 degree swing.
   1. Provide hinge stops, where cabinet door, open 90 degrees, will hit wall, casework or equipment.

E. Bumper: Clear rubber.


G. Magnetic Catch: heavy-duty magnetic with a maximum 5 lb., minimum 3 lb. pull.

H. Drawer Glides: Knape & Vogt or equivalent by Accuride, full extension type as follows:
   1. No. 8405 at 6-inch and less.
   2. No. 8505 at drawers greater than 6 inches deep.

I. File Drawer Hardware:
   1. Drawer Glides: Load rating of 150 pounds, ball bearing, full extension.
   2. Pentaflex file hangers and allow 1" clearance between top of hanging files and top edge of file drawer.
   3. All file drawers to extend to allow 1" clearance between files and face of cabinet.

J. Locks: Olympus, 700SC and 800SC. Provide locks where shown. Key locks separately. Provide 3 keys per lock.

K. Multiple hole adjustable shelf support:
   1. Each shelf shall have 5 mm nickel plated steel, plug-in, retainer type security pin support clips let into shelf bottoms to prevent sliding.
   2. Drill shelf clip holes at 1-1/4 inch on center, full height of cabinet, two columns per cabinet side.
   3. Provide four support clips at each shelf indicated, six at shelves over 42 inches in length.

L. Glass Display Shelf Supports: Knape & Vogt or equivalent:
   1. Standard: No. 255AL, 5 per compartment.
2. Shelf Support: 256AL NAT.
3. Accessories: Clear rubber cushion for glass support.

M. Sliding Glass Door Hardware: Knape & Vogt or equivalent for 1/4 inch glass:
   1. Door Glide and Track Set: P992 ZC full length
   2. Bumpers: 1087, top and bottom both jambs.
   3. Door Pull: Cut and polish 1-1/4 inch hole in glass.

N. Swinging Glass Display Case Door and Hardware:
   1. Lock: C. R. Laurence Co., Inc., or equivalent
      a. Type: 703CORB.
      b. Finish: Oil rubbed bronze.
   2. Hinge: C. R. Laurence Co., Inc., or equivalent
      a. Type: Vienna wall mount offset plate hinges; V1E044ORB
      b. Finish: Oil rubbed bronze.
   3. Swinging Glass Door
      a. Tempered glass, 5/16 inch thick; see Section 08 80 00.

O. For concealed hardware provide manufacturer's standard finish that complies with product class requirements of ANSI/BHMA A156.9.

2.05 PLASTIC LAMINATE CLAD CABINETS

A. Grade: Custom.
B. Style: Flush overlay.
C. Wet area core, MDF-X, at the following locations:
   1. Sink cabinets.

D. Plastic Laminate Cladding:
   1. Exposed Horizontal Surfaces: HPDL VGS.
   2. Exposed Vertical Surfaces: HPDL VHS.
   3. Door Backs: HPDL VGS, match face.
   4. Semi-exposed Surfaces: TDO.
   5. PVC Edge banding
   6. Semi-exposed Surfaces: HPDL BS, neutral color selected by Architect

E. Drawers: Full depth of case.
F. Adjustable Shelves: 1 per 12 inches unless indicated otherwise.
G. Base Cabinet Toe: 4 inches high, 3 inches deep.
H. Underside of Wall Cabinet: Type "B" flush, each cabinet finished individually.
I. Chases and Cabinet Superstructures: Provide access panels to chases with one of the following:
   1. Phillips oval head screws with grommets.
   2. "Velcro" hook and loop fasteners is with finger hole pull.

2.06 MDF CABINETS

A. Grade: Premium.
B. Style: Flush Overlay
C. Panels, Doors, Drawer Fronts, Shelves: ¾ inch thick MDF
   1. Panel Edges: Natural, sanded, eased edges
   2. Corners: eased
   3. Semi-exposed Surfaces: MDF
   4. Semi-exposed Backs: MDF.
D. Drawers: Full depth of case.
E. Adjustable Shelves: 1 per 12 inches unless indicated otherwise.
F. Base Cabinet Toe: 4 inches high, 3 inches deep.

G. Underside of Wall Cabinet: Type “A” flush, each cabinet finished individually.

H. Finishes: Transparent finish, exposed and semi-exposed surfaces, seal concealed surfaces.
   2. Casework 2: Red stain.

2.07 CABINET FABRICATION

A. Wood Moisture Content: Comply with requirements of referenced quality standard for moisture content of lumber in relation to relative humidity conditions existing during time of fabrication and in installation areas.

B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Corners of cabinets and edges of solid wood (lumber) members less than 1 inch in nominal thickness: 1/16 inch.
   2. Edges of rails and similar members more than 1 inch in nominal thickness: 1/8 inch.

C. Complete fabrication, including assembly, finishing, and hardware application, before shipment to project site to maximum extent possible. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

D. Factory-cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Field cutting of sink and grommet cutouts allowed. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Smooth edges of cutouts and, where located in countertops and similar exposures, seal edges of cutouts with a water-resistant coating.

E. Rear edges of upper cabinets shall be concealed. No rear of any cabinet shall be exposed. Rears of upper cabinets shall be inserted into rabbits to allow for scribe for a tight fit against wall.

F. Edge Band: Pressure bonded to core with waterproof, hot melt adhesive at exposed and semi-exposed edges.

G. Drawer Box Construction: Lock shoulder.

H. Shelf Supports: Recessed standards with adjustable shelf support, 4 at shelves 32 inches wide and less, 5 at shelves wider than 32 inches.

I. Shelves: ¾ inch thick core less than 32 inches, 1 inch thick core greater than 32 inches any dimension.

J. All cabinetry enclosing flipper door hardware to be completely removable for access and removal of flipper door hardware.

2.08 COUNTERTOP FABRICATION, GENERAL

A. Comply with AWI Section 400, Division 400C. Premium grade unless indicated otherwise.

B. Counter-Mounted Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

C. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

D. Provide ¾ inch thick marine plywood sub-top and metal supports where no base cabinets support countertop.
   1. Metal supports indicated in Drawings, fabricated per Section 05 50 00, opaque paint finish per Section 09 90 00.

2.09 LAMINATED COUNTERTOPS

A. Grade: Premium.
ARCHITECTURAL WOOD CASEWORK

B. Core: MDF-X, 3/4 inch thick with 1-1/2 inch built-up edges.

C. HPDL Finish:
   1. Exposed Surfaces: HGS/HFS (0.050-inch nominal thickness).
   2. Balance Sheet: 0.020-inch thick minimum, matching top color where exposed.
   3. Provide self-edge unless wood edge is indicated in Drawings.

D. Wood Veneer Finish: Transparent finish.

E. Wood Edge: [1/8][Insert Option Here] inch thick, [match wood veneer][lumber][maple], transparent finish.

F. Splashes: [HPDL VGS or HGS][Insert Option Here], scribe top edge to wall.
   1. 4 inch high unless indicated otherwise.

2.10 MANUFACTURED STONE TOPS AND PANELS

A. Fabricate tops and panels per Manufacturer’s instructions.

B. Polish surfaces.

C. Exposed Edges and Corners: pencil round.

D. Hair line joints where surface dimension exceeds available product length.

E. Stone Top Accessories: Adhesive, cleaner and penetrating sealer recommended by stone Manufacturer.

F. Shop Finish for SlateScape: Manufacturer’s recommended blend of lithiphin oil and tung oil.
   1. Do not seal adhered surface.

2.11 WALL SHELVING

A. Quality: AWI Section 600, Custom grade.

B. Shelves: HPDL laminated MDF-X, matching PVC edge.
   1. Janitor Closet: 16 inches deep on wall support.
   2. Closets: Fixed with ledger and clothes rod. Depth indicated in Drawings.

C. Wall Supports: Knapp & Vogt, extra heavy duty standards and supports.
   1. Standard: No. 85ANO-84.
   2. Shelf Support: Double bracket, No. 185ANO-16, 16 inches deep.

2.12 UPHOLSTERED WALL

A. Provide cushion foam core cut to size and profile indicated in Drawings. Wrap and seal core with moisture barrier liner.

B. Fabric Cover: Full cover, tailored to fit cushion, concealed seams, removable for washing via a zipper along back edge and corners.

C. See Schedule for upholstery fabrics.

2.13 SHOP FINISHING

A. Wood Finishes: AWI Section 1500 Premium grade.

B. Transparent Finish: Catalyzed conversion varnish, satin sheen, clear.

PART 3 - EXECUTION

3.01 PREPARATION

A. Before installing casework, examine shop-fabricated work for completion and complete work as required.

B. Measure all areas for scribe fit.

3.02 INSTALLATION

A. Comply with AWI Section 1700 for specified grade, and the following.
B. Install casework plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level (including tops) and with no variations in flushness of adjoining surfaces.

C. Scribe and cut casework to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.

D. Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated.
   1. Mount wall cabinets to resist 200 pounds per linear foot.

E. Tops: Anchor securely to base units and other support systems as indicated.
   1. Anchor tops to support 400 pound concentrated load.

F. Sinks: Verify sink locations and sizes before cutting openings in countertops.

G. Complete the finishing work specified in this section to whatever extent not completed at shop or before installation of casework.

3.03 ADJUSTMENT AND CLEANING
   A. Repair damaged and defective casework where possible to eliminate defects functionally and visually; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
   B. Clean, lubricate, and adjust hardware.
   C. Clean casework on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.04 PROTECTION
   A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensures that casework is being without damage or deterioration at time of Substantial Completion.

3.05 SCHEDULE
   A. Plastic Laminate (PLAM):
      1. PLAM-1
         a. Location: Craft Center
         b. Manufacturer: Wilsonart
         c. Color: D90-60 North Sea
         d. Finish: Matte
      2. PLAM-2
         a. Location: Countertops
         b. Manufacturer: Wilsonart
         c. Color: Solicor D354-60 Designer White
      3. PLAM-3
         a. Location: Vertical Surfaces
         b. Manufacturer: Formica
         c. Color: 7747-58 Pencil Wood
         d. Finish: Matte.
   B. Plywood (PWD):
      1. PWD-1
         a. Location: Countertops
         b. Manufacturer: TBD
         c. Product: Plywood
      2. PWD-2
         a. Location: Wet location countertops
         b. Manufacturer: TBD
         c. Product: Marine Grade Plywood
C. Solid Surface (SS):
   1. SS-1
      a. Location: Package 2-5 Program Areas Countertop
      b. Manufacturer: LG Hausys
      c. Color: Arctic White S06
      d. Size: 1/2 inch.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Custom wood veneer paneling.
B. Solid wood panel trim.
C. Shop finishing.

1.02 REFERENCE STANDARDS
A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.
C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; Hardwood Plywood & Veneer Association; 2009 (ANSI/HPVA HP-1).

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on fire retardant treatment materials and application instructions.
C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot.
   2. Include plan of panel number sequencing.
   3. Provide the information required by AWI/AWMAC/WI Architectural Woodwork Standards.
D. Samples: Submit two samples of finished plywood, 12 x12 inch in size, illustrating wood grain and specified finish.
E. Samples: Submit two samples of wood trim, 12 inch long.
F. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit MR 2: Waste Material Tracking Form, Section 01 74 19.
   3. Credit MR 5: (Regional) Straight-line distance to Manufacturer and distance to material extraction for each product. If greater than 500 miles, report “> 500”. Product cost data.
   5. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   6. Credit EQ 4.2: Manufacturers’ product data for paints, including printed statement of VOC content and statement concerning list of prohibited chemicals.
   7. Credit EQ 4.4: Composite wood manufacturer’s product data for each composite wood product used indicating that bonding agent used contains no urea formaldehyde.

1.04 QUALITY ASSURANCE
A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
   1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
   2. Single Source Responsibility: Provide and install this work from single fabricator.

1.05 REGULATORY REQUIREMENTS
A. Conform to applicable code for fire retardant requirements.

1.06 MOCK-UP
A. Construct mock-up, 8 feet long by full height of finished paneling indicated on drawings, illustrating full panel sheet, edge trim, joint trim, applied finish
B. Locate where directed.
C. Approved mock-up may remain as part of the Work.
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Protect work from moisture damage.
   B. Do not deliver wood materials to project site until building is fully enclosed and interior
temperature and humidity are in accordance with recommendations of AWI/AWMAC/WI
Architectural Woodwork Standards.

PART 2 PRODUCTS

2.01 PANELING
   A. Quality Grade: Unless otherwise indicated provide products of quality specified by
AWI/AWMAC/WI Architectural Woodwork Standards for Premium Grade.
   B. Flat Paneling:
      1. Species: TBD.
      2. Cut: TBD.
      3. Panels: Veneer of full width and balanced sequence matched.
      4. Panels: Tongue and Groove to match solid wood doors; see Section 08 14 16.
      5. Visible Edges and Reveal: Match faces.
      6. Outside Corners: Mitered and splined.
      7. Blueprint Match: Room __________.
      8. Blueprint Match:
         a. Grade: Premium.
         b. Provide casework, paneling, doors and wood trim by same manufacturer.
         c. Factory finish components including casework, paneling, doors, and trim at the same
time in the same facility.
   C. Reclaimed Ceiling Wood:
      1. Refurbish wood with light sanding, end trimming, pin/adhesive attachment and applied
finish.

2.02 WOOD-BASED MATERIALS - GENERAL
   A. Wood fabricated from old growth timber is not permitted.

2.03 ADHESIVES AND FASTENERS
   A. Adhesives: Type suitable for intended purpose, no urea formaldehyde and complying with
applicable air quality regulations.
   B. Fasteners: Of size and type to suit application.

2.04 ACCESSORIES
   A. Lumber for Shimming, Blocking: Softwood lumber of any species.
   B. Wood Filler: Tinted to match surface finish color.

2.05 FABRICATION
   A. Prepare panels for delivery to site, permitting passage through building openings.
   B. Finish exposed edges of panels as specified by grade requirements.

2.06 SHOP FINISHING
   A. Sand work smooth and set exposed nails and screws.
   B. Apply wood filler in exposed nail and screw indentations.
   C. Finish work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 5
   - Finishing for Grade specified and as follows:
      1. Transparent:
         a. System - 12, Polyurethane, Water-based.
         b. Stain: As selected by Architect.
         c. Sheen: Satin.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify adequacy of backing and support framing.
C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION
A. Install work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards requirements for grade indicated.
B. Do not begin installation until wood materials have been fully acclimated to interior conditions.
C. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.
D. Where necessary to cut and fit on site, scribe work abutting other components. Do not use additional overlay trim to conceal gaps.
E. Coordinate the installation of firestopping behind paneling.

3.03 TOLERANCES
A. Maximum Variation from True Position: 1/16 inch.
B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

3.04 SCHEDULE
A. WCW-1
   1. Location: Boulevard
   2. Manufacturer: TBD
   3. Product: Adhered Wood Veneer
   4. Application: Doors and wall panels

B. WC-2
   1. Location: Food Service
   2. Manufacturer: TBD
   3. Product: Adhered Wood Veneer
   4. Application: Walls and Vertical Counter Faces

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fiberglass reinforced polyester panel system for adhesive mounting.
B. Moldings, adhesive, and joint sealants.

1.02 REFERENCES

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
C. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 35 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
E. Maintenance Instructions.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
1.05 PROJECT CONDITIONS
   A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Acceptable Manufacturer:
      1. Marlite; www.marlite.com
      2. Kemlite Company, Inc.
   B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PANEL SYSTEM
   B. FRP Panels: Fiberglass reinforced polyester, USDA approved for incidental food contact.
      1. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E 84 (Class A/I).
      2. Surface Texture: Gently pebbled, high-gloss.
      3. Color: As selected from manufacturer's standard selection.
      5. Width: 48 inches.
      6. Height: 96 inches.
      7. Flexural Strength: 10,000 psi, when tested in accordance with ASTM D 790.
      8. Flexural Modulus: 3,100 psi, when tested in accordance with ASTM D 790.
      9. Tensile Strength: 7,000 psi, when tested in accordance with ASTM D 638.
     10. Tensile Modulus: 1,600,000 psi, when tested in accordance with ASTM D 638.
     11. Barcol Hardness: 35, when tested in accordance with ASTM D 2583.
     13. Coefficient of Thermal Expansion: 0.0000157 in/in/degree F, measured in accordance with ASTM D 696.
     14. Water Absorption: 0.72 percent, when tested in accordance with ASTM D 570.
     15. Specific Gravity: 1.8, when tested in accordance with ASTM D 792.
   C. Panel Trim: Extruded PVC, in manufacturer's standard colors.
      1. Outside corners, inside corners, edge trim, and division molding.
   D. Sealant: Manufacturer's Silicone Sealant; gunnable silicone rubber; Match panel color.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Do not begin installation until substrates have been properly prepared.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
   A. Take panels out of cartons and allow to acclimatize to room conditions for at least 48 hours prior to installation.
   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
   C. Clean surfaces thoroughly prior to installation.
   D. Protect existing surfaces from damage due to installation.

3.03 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
B. Use the adhesives recommended by the panel manufacturer unless prohibited by local regulations; obtain manufacturer's approval of alternative adhesives.

C. Install continuous bead of silicone sealant in each joint and trim groove and between trim and adjacent construction, maintaining 1/8 inch expansion space.

D. Avoid contamination of panel faces with adhesives, solvents, or cleaners; clean as necessary and replace if not possible to repair to original condition.

E. Protect installed products until completion of project.

F. Touch-up, repair or replace damaged products after Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Bituminous dampproofing.
   B. Drainage panels.

1.02 REFERENCE STANDARDS
   A. NRCA ML104 - The NRCA Roofing and Waterproofing; National Roofing Contractors Association; Fifth Edition, with interim updates.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide properties of primer, bitumen, and mastics.
   C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.04 QUALITY ASSURANCE
   A. Perform work in accordance with NRCA Roofing and Waterproofing Manual.
   B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.
   C. Use complete system that is provided by a single Manufacturer source.

1.05 FIELD CONDITIONS
   A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Design Basis: Sonneborn; Product Hydrocide 700B; www.
   B. Basis-of-Design Product: Subject to compliance with requirements, provide dampproofing systems from Sonneborn by BASF Building Systems. Manufacturers providing comparable products that may be incorporated into the Work include, but are not limited to, the following:
      5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COLD ASPHALTIC MATERIALS
   A. Bitumen: Cold applied, water based emulsified asphalt, ASTM D 1227; with fiber reinforcement other than asbestos (Type III, Class 1).
   B. Asphalt Primer: As recommended by manufacturer of dampproofing.
   C. Sealing Mastic: As recommended by manufacturer of dampproofing.

2.03 ACCESSORIES

PART 3 EXECUTION

3.01 PREPARATION
   A. Protect adjacent surfaces not designated to receive dampproofing.
   B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.
C. Do not apply dampproofing to surfaces unacceptable to manufacturer.
D. Apply mastic to seal penetrations, small cracks, or minor honeycomb in substrate.

3.02 APPLICATION
A. Prime surfaces in accordance with manufacturer's instructions.
B. Apply bitumen by spray application or roller.
C. Apply bitumen in one coat, continuous and uniform, at a rate of 1.5 gal/100 sq ft per coat.
D. Apply from 2 inches below finish grade elevation down to top of footings.
E. Seal items projecting through dampproofing surface with mastic. Seal watertight.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Sheet membrane waterproofing.
   B. Cant strips and other accessories.
   C. Drainage panels and Protection boards.

1.02 RELATED REQUIREMENTS
   A. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal parapet, coping, and counterflashimg.

1.03 REFERENCE STANDARDS
   E. ASTM D1876 - Standard Test Method for Peel Resistance of Adhesives (T-Peel Test); 2008.
   I. ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2013).

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data for membrane.
   C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
   D. Certificate: Certify that products meet or exceed specified requirements.
   E. Manufacturer's Installation Instructions: Indicate special procedures.
   F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
   A. Perform Work in accordance with NRCA Roofing and Waterproofing Manual for waterproofing system.
   B. Membrane Manufacturer Qualifications: Company specializing in waterproofing sheet membranes with three years experience.
   C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience.

1.06 FIELD CONDITIONS
   A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.
1.07 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Contractor shall correct defective Work within a five year period after Date of Substantial Completion; remove and replace materials concealing waterproofing at no extra cost to Owner.
   C. Provide five year manufacturer warranty for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 PRODUCTS
2.01 MEMBRANE MATERIALS
   A. Self-Adhered Modified Bituminous Membrane:
      1. Thickness: 60 mil (0.060 inch).
      2. Tensile Strength:
         a. Film: 5000 pounds per square inch, minimum, measured according to ASTM D882 and at grip-separation rate of 2 inches per minute.
         b. Membrane: 325 pounds per square inch, minimum, measured according to ASTM D412 Method A, using die C and at spindle-separation rate of 2 inches per minute.
      3. Elongation at Break: 300 percent, minimum, measured according to ASTM D412.
      4. Water Vapor Permeance: 0.05 perm, maximum, measured in accordance with ASTM E96/E96M.
      5. Low Temperature Flexibility: Unaffected when tested according to ASTM D1970 at minus 20 degrees F, 180 degree bend on 1 inch mandrel.
      6. Peel Strength: 7 pounds per inch, minimum, when tested according to ASTM D903.
      7. Lap Adhesion Strength: 5 pounds per inch, minimum, when tested according to ASTM D1876.
      8. Puncture Resistance: 50 pounds, minimum, measured in accordance with ASTM E154.
      9. Water Absorption: 0.1 percent increase in weight, maximum, measured in accordance with ASTM D570, 24 hour immersion.
     10. Hydrostatic Resistance: Resists the weight of 200 feet when tested according to ASTM D5385.
     11. Adhesives, Sealants, Tapes, and Accessories: As recommended by membrane manufacturer.
     12. Manufacturers:
         d. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ACCESSORIES
   A. Primer: Type recommended by membrane manufacturer.
   B. Sealant for Substrate Surfaces: Type specified in Section 07 90 05 and recommended by membrane manufacturer.
   C. Drainage Panel: Drainage layer with geotextile filter fabric on earth side.
         a. Products:
            4) Substitutions: See Section 01 60 00 - Product Requirements.
   D. Cant Strips: Premolded composition material.
   E. Flexible Flashings: Type recommended by membrane manufacturer.
F. Counterflashings: Stainless steel as specified in Section 07 62 00.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.
C. Verify that items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION
A. Protect adjacent surfaces not designated to receive waterproofing.
B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions. Vacuum substrate clean.
C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.
D. Seal cracks and joints with sealant using depth to width ratio as recommended by sealant manufacturer.
E. Surfaces for Adhesive Bonding: Apply surface conditioner at a rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

3.03 INSTALLATION - MEMBRANE
A. Install membrane waterproofing in accordance with manufacturer's instructions.
B. Roll out membrane. Minimize wrinkles and bubbles.
C. Self-Adhering Membrane: Remove release paper layer. Roll out on substrate with a mechanical roller to encourage full contact bond.
D. Adhesive Bonded Membrane: Apply adhesive in accordance with manufacturer's instructions. Bond sheet to substrate except those areas directly over or within 3 inches of a control or expansion joint.
E. Overlap edges and ends and seal by method recommended by manufacturer, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
F. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.
G. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.
H. Install flexible flashings. Seal items penetrating through membrane with flexible flashings. Seal watertight to membrane.
I. Seal membrane and flashings to adjoining surfaces. Install termination bar at all edges. Install counterflashing over all exposed edges.

3.04 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD
A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward. Scribe and cut boards around projections, penetrations, and interruptions.
B. Place protection board directly against drainage panel; butt joints. Scribe and cut boards around projections, penetrations, and interruptions.

3.05 FIELD QUALITY CONTROL
A. On completion of horizontal membrane installation, dam installation area in preparation for flood testing.
B. Flood to minimum depth of 1 inch with clean water. After 48 hours, inspect for leaks.
C. If leaking is found, remove water, repair leaking areas with new waterproofing materials as directed by Architect; repeat flood test. Repair damage to building.
D. When area is proven watertight, drain water and remove dam.
3.06 PROTECTION

A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Bentonite clay waterproofing membrane and accessories that form a complete, watertight system.
B. Applications include:
   1. Elevator pit floor and sump floor, placed prior to concrete.
   2. Elevator pit walls and sump walls, vertical on cast concrete.
   3. Full perimeter of foundation wall and footings, vertical on cast concrete with drainage panel.
C. This specification is based on the Design Basis Manufacturer's specification to assure completeness. Although named products are used throughout this Section, the Owner intends open bidding by comparable systems.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product criteria, characteristics, accessories, jointing and seaming methods, and termination conditions.
C. Shop Drawings: Indicate required flashings, control joints, and expansion joints, sealing at openings, projections, penetrations, reglets, sleeves, and at drainage panel interface with drainage system.
D. Certificate: Certify that products meet or exceed specified requirements.
E. Contractor Certificate: At time of bid, submit written certification that installer has current Approved Applicator status with waterproofing material manufacturer.
F. Manufacturer's Installation Instructions: Indicate special preparation of substrate, panel attachment methods, and perimeter conditions requiring special attention.
G. Manufacturer's technical representative field observations.
H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE
A. Perform Work in accordance with NRCA Waterproofing and Dampproofing Manual, NRCA ML104; current edition and up-dates.
B. Waterproofing system and components, drainage and protection materials are to be supplied by a single-source manufacturer to assure compatibility.
C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience.
   1. Installer on site must be an Approved Applicator as determined by waterproofing/drainage system Manufacturer.
D. Manufacturer's Technical Representative:
   1. Visit site not less than three times, if required, to review technical aspects critical to waterproofing application, and installation procedures to assure compliance with manufacturer's installation requirements for for issuance of warranty.
      a. Pre-installation Conference.
      b. Installation of mock-up, and beginning of installation for observation of substrate suitability for waterproofing application.
      c. Observation of completed installation.
   2. Document site visits in writing with copy to Architect.
E. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field installation to establish procedures to maintain required working conditions and to coordinate this work with related and adjacent work. Verify that final waterproofing and waterstop details comply with waterproofing manufacturer’s current installation requirements.
and recommendations for full warranty compliance. Pre-installation meeting attendees should include representatives for the owner, architect, general contractor, waterproofing manufacturer, waterproofing contractor, concrete contractor, excavating/backfill contractor, and mechanical and electrical contractors if work penetrates the waterproofing.

1.04 MOCK-UP
   A. Construct mock-up of 100 sq ft of horizontal waterproofing, representing finished work including internal and external corners.
   B. Locate where directed.
   C. Approved mockup may remain as part of the Work if undisturbed at time of covering.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Delivery and Handling: Deliver materials in factory sealed and labeled packaging. Sequence deliveries to avoid delays, while minimizing on-site storage. Handle and store following manufacturer's instructions, recommendations and material safety data sheets. Protect from construction operation related damage, as well as, damage from weather, excessive temperatures and prolonged sunlight. Remove damaged material from site and dispose of in accordance with applicable regulations.
   B. Storage: Do not double-stack pallets during shipping or storage. Protect waterproofing materials from moisture, excessive temperatures and sources of ignition. Provide cover, top and all sides, for materials stored on-site, allowing for adequate ventilation.
      1. Maintain bentonite products dry. Protect with waterproof cover.
      2. Maintain minimum ambient storage temperatures of 40 degrees F for bentonite gel products.

1.06 FIELD CONDITIONS
   A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application unless otherwise required by waterproofing manufacturer.
   B. Substrate Condition: Proceed with work only when substrate construction and preparation work is complete and in condition to receive waterproofing system.
   C. Weather Conditions: Perform work only when existing and forecasted weather conditions are within the guidelines established by the manufacturer of the waterproofing materials. Do not apply waterproofing materials into standing water or over ice and snow. Though exposure to precipitation and ground water seepage typically will not adversely affect waterproofing sheets, the Contractor shall maintain site conditions to remove standing water from precipitation or ground water seepage in a timely manner. Should waterproofing sheets be subjected to prehydration as a result of prolonged immersion, inspection of the material and written acceptance from Manufacturer is required prior to concrete or backfill placement.

1.07 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Contractor shall correct defective Work within a five year period after Date of Substantial Completion; remove and replace materials concealing waterproofing at no extra cost to Owner.
   C. Waterproofing Warranty: Upon completion and acceptance of the work required by this section, the waterproofing materials manufacturer will provide to the project owner, a written ten (10) year warranty, covering both materials and labor, for waterproofing failing to resist penetration of water. Issuance of Manufacturer's Warranty requires the following:
      1. System waterproofing products and drainage composite products shall have been provided by a single manufacturer;
      2. Installation of waterproofing products and prefabricated drainage composite by Manufacturer's Approved Applicator;
      3. Installation inspected by Independent Inspection Firm.
      4. Warrant horizontal and vertical cold pour concrete construction joints and penetrations water stop from Manufacturer.
5. Warranty Exclusion: Where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 PRODUCTS

2.01 MANUFACTURERS


B. Comparable System: Submit complete data and details with comparisons that clearly indicate substitution is comparable and clearly delineated item for item being substituted.
   1. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Volclay, Voltex DS: Bentonite geotextile waterproofing with integral polyethylene liner. High strength geotextile, 1.10 pounds of sodium bentonite per square foot, with integrally bonded polyethylene liner with the following characteristics:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>TYPICAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrostatic Pressure Resistance</td>
<td>ASTM D 5385 (mod.)</td>
<td>231 ft. (70 m)</td>
</tr>
<tr>
<td>Permeability</td>
<td>ASTM D 5084</td>
<td>&lt;1 x 10 to the -10 cm/sec.</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D 4632</td>
<td>95 lbs.</td>
</tr>
<tr>
<td>Puncture Resistance</td>
<td>ASTM D 4833</td>
<td>100 lbs.</td>
</tr>
<tr>
<td>Low Temperature Flexibility</td>
<td>ASTM D 1970</td>
<td>Unaffected at -25°F (-32°C)</td>
</tr>
<tr>
<td>Peel Adhesion to Concrete</td>
<td>ASTM D 903 (mod.)</td>
<td>15 lbs/in.</td>
</tr>
</tbody>
</table>

2.03 ACCESSORIES

A. Volclay Bentoseal®: Trowel grade sodium bentonite compound used as a detailing mastic around penetrations, corner transitions and grade terminations.

B. Volclay Hydrobar Tubes: 2” (50 mm) diameter x 2’ (60 cm) long, water soluble tube container filled with granular sodium bentonite.

C. Volclay Waterstoppage®: 50 lbs. (22.7 kg) bag of granular Volclay sodium bentonite.

D. Volclay SeamTape®: 2” (50 mm) wide butyl rubber sealant tape.

E. Termination Bar: Min. 1” (25 mm) wide aluminum bar with pre-punched holes on 12” (300 mm) centering for fastening.

F. Volclay Waterstop-RX. Installation in Section 03 30 00 in compliance with requirements in this Section.

G. Aquadrain: Subsurface drainage composite consisting of a heavy filter fabric adhered to a high-strength plastic drainage core.

H.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify substrate surfaces are smooth and durable; free of matter detrimental to application of waterproofing system.

C. Verify that items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

A. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.

B. Remove concrete fins, projections, and form ties.

C. Fill holes, cracks, honeycombs, and voids with bentonite gel seal, minimum 1/8 inch thick, extending minimum 3 inches beyond defect.
3.03 APPLICATION - GENERAL
A. Install waterproofing in accordance with manufacturer's instructions.
B. Place waterproofing membrane over the properly prepared substrate with the dark gray (woven) geotextile side up. Overlap all adjoining edges a minimum 4 inches and stagger sheet ends a minimum 12 inches. Fasten and seal edges together as required to prevent any displacement before and during concrete placement.
C. Cut waterproofing membrane to tightly fit around penetrations. Install Waterstoppage under cut edge at detailing and apply a minimum 3/4 inch thick fillet of Bentoseal to top of cut edge at penetrations, and other detailing.

3.04 SLAB / BACKFILLED WALL FOOTING EDGE TRANSITION COURSE
A. Inside the slab/footing form edge, secure Voltex DS sheet horizontally oriented (poly side down; dark gray geotextile facing installer) to the top inside edge of the exterior slab/footing form with the sheet conforming to the interior form surfaces and then extending out onto the horizontal slab substrate a minimum 12 inches. Overlap edges of adjacent Voltex DS sheets a minimum 4 inches and secure to prevent sheet movement during construction or concrete placement.

3.05 BELOW SLABS UNDER HYDROSTATIC CONDITIONS
A. Place polyethylene sheet over subgrade; lap joints 4 inches.
B. Install Voltex DS under all footings, elevator pits and grade beams when hydrostatic conditions exists or are anticipated per the historical high ground water elevation reported in the project’s geotechnical documents.
C. Install Voltex DS membrane (poly side down; dark gray geotextile side up) extending to interior edge of footing/slab edge, fully overlapping the 12 inches horizontal tail of the Voltex DS slab edge sheet installed in Section 3.04A (above). Overlap edges of adjacent Voltex DS sheets a minimum 4 inches and secure to prevent sheet movement during construction or concrete placement.
D. Place Voltex DS directly on properly prepared substrate (poly side down; dark gray geotextile side up facing installer) with adjoining edges overlapped a minimum of 4 inches. Stagger sheet end seams a minimum of 24 inches. Mechanically fasten or staple Voltex DS as required to prevent movement from construction operations or concrete placement. When the slab is poured in sections, extend Voltex DS a minimum 12 inches beyond the slab edge to enable proper overlapping.
E. Install waterproofing system at all grade beams, pile caps, and other detail areas in accordance with manufacturer's detail for specific project condition(s).
F. Slab Penetrations: For all pipe, rebar, structural or other penetrations install waterproofing system in accordance with manufacturer's standard detail for specific project condition(s).
G. Inspect finished Voltex DS installation and repair any damaged material prior to concrete slab placement.

3.06 VERTICAL BACKFILLED SURFACES
A. Before installing the first course of Voltex DS, place Hydrobar Tubes at the wall/footing transition corner. Butt the ends of Hydrobar Tubes together to form a continuous line. Beginning at the bottom corner of the wall, install Voltex DS horizontally oriented with 5-ft. on one wall and the remainder around the corner on the other wall surface. Cut the bottom edge of Voltex DS at the corner a minimum of 6 inches so that Voltex DS can be extended onto the footing. Fasten Voltex DS into position with washer headed fasteners a minimum of 24 inches on center. Then cut and install a Voltex DS section over the uncovered footing corner area. Apply Bentoseal at the Voltex DS section to Voltex DS overlap at the corner. Overlap all adjacent sheet edges a minimum 4 inches. Stagger all vertical overlap seams a minimum of 12 inches. Tape all membrane overlap seams with CETCO Seamtape.
B. After the bottom horizontal course, Voltex DS sheets can be installed either vertically or horizontally oriented. Continue Voltex DS installation up wall to finished grade elevation detail, staggering all sheet roll ends of adjacent courses a minimum 12 inches. Do not allow horizontal Voltex DS overlap joints to run at same elevation as the concrete pour lift joints. Overlap all adjacent Voltex DS sheet edges a minimum 4 inches and secure with washer-head fastener maximum 24 inches on center. Tape all membrane overlap seams with CETCO Seamtape.

C. Penetrations: For all pipe, rebar, structural and other penetrations install waterproofing system in accordance with manufacturer’s detail for specific project condition(s).

D. Terminate Voltex DS membrane 12 inches below finished grade elevation secured with washer-head fasteners maximum 12 inches on center to exterior surface of concrete wall. Per manufacturer’s detail for specific project condition(s), install GS-40SA grade flashing to primed concrete substrate with bottom edge overlapping top edge of Voltex DS membrane minimum 4 inches. Overlap all roll ends a minimum 4 inches to form a continuous flashing. Height of flashing shall be per project details and specifications. Install a rigid termination bar along the top edge of GF-40SA; fastened maximum 12 inches on center. Complete grade termination detail with tooled bead of CETSEAL along the top edge, at all penetrations through the flashing, and all exposed overlap seams.

E. Inspect finished Voltex DS installation and repair any damaged material prior to backfill placement. Assure that Voltex DS is not displaced during backfill placement or soil compaction.

3.07 INSTALLATION - DRAINAGE PANEL

A. Place drainage panel directly over shoring, butt joints, place to encourage drainage downward.

B. Scribe and cut boards around projections, penetrations, and interruptions.

3.08 VERTICAL SHOTCRETE PROPERTY LINE SURFACES - HYDROSTATIC CONDITIONS

A. Waterproof cast-in-place property line construction at shotcrete stabilized-earth shoring wall. Begin installation with drainage panel as indicated in 3.07 above.

B. Property Line Shoring Walls: Install Voltex DS with minimum 6 inch sheet edge overlaps fastened with both washer-head fasteners placed maximum 24 inches on center and pneumatic staples placed 6 inches on center. Install pneumatic staples within 1 inch of sheet edge to tightly secure entire overlap assembly to the shoring wall.

C. Secure center line of Voltex DS sheets to shoring wall with pneumatic staples or washer-head fasteners as required to hold membrane tight against shoring wall.

D. Prior to installing adjacent Voltex DS sheets, apply continuous ¼ inch thick by 3 inch wide trowel of Bentoseal along top and side edges of previously installed Voltex DS sheet. Install Bentoseal so that it will be confined toward the center of the 6 inch overlap. In lieu of Bentoseal, a minimum 3/8 inch bead of Akwaswell can be used within the overlaps.

E. Expansion Joints: Voltex DS waterproofing is not an expansion joint filler or sealant, but may be used as an expansion joint cover over properly installed expansion joint material placed during substrate preparation. To use Voltex DS as an expansion joint cover, trowel 1/8 inch thick, 6 inch wide layer of Bentoseal centered over expansion joint. Install a 24 inches wide strip of Voltex DS centered over the expansion joint. Then place the main course of Voltex DS.

3.09 PROTECTION

A. Do not permit traffic over unprotected or uncovered waterproofing.

B. Cover installed waterproofing with temporary sheeting. Remove sheeting just before covering of waterproofing begins.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clear penetrating water-repellent for the following vertical surfaces:
   1. Brick.
   2. CMU
   3. Concrete and Portland Cement Plaster (Stucco)
   4. Stone

B. Clear penetrating graffiti control repellent

1.02 PERFORMANCE REQUIREMENTS

A. Provide water repellents and anti-graffiti coating with the following properties based on testing manufacturer's standard products, according to test methods indicated, applied to substrates simulating Project conditions using same materials and application methods to be used for Project.

B. Absorption: Minimum 90 percent reduction of absorption after 24 hours in comparison of treated and untreated specimens.
   2. Concrete Unit Masonry: ASTM C 140.
   3. Hardened Concrete or Stucco: ASTM C 642.

C. Water-Vapor Transmission: Maximum 10 percent reduction in rate of vapor transmission in comparison of treated and untreated specimens, per ASTM E 96.

D. Permeability: Minimum 80 percent water-vapor transmission in comparison of treated and untreated specimens, per ASTM D 1653.

E. Water Penetration and Leakage through Masonry: Maximum 90 percent reduction in leakage rate in comparison of treated and untreated specimens, per ASTM E 514.

F. Durability: Maximum 5 percent loss of water repellency after 2500 hours of weathering in comparison to specimens before weathering, per ASTM G 154.

G. Delete paragraph and subparagraphs below if application is not on reinforced concrete surface, including traffic-bearing horizontal surfaces such as parking decks. Test results below are examples only; revise to suit Project.

H. Chloride-Ion Intrusion in Concrete: NCHRP Report 244, Series II tests.
   1. Reduction of Water Absorption: 80 percent.
   2. Reduction in Chloride Content: 80 percent.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Include manufacturer's specifications, surface preparation and application instructions, recommendations for water repellents for each surface to be treated, and protection and cleaning instructions. Include data substantiating that materials are recommended by manufacturer for applications indicated and comply with requirements.

C. Applicator Certificates: Signed by manufacturer certifying that the applicator complies with requirements.

D. Certification by water repellent manufacturer that products supplied comply with local regulations controlling use of VOCs.

E. Material Test Reports: Indicate and interpret test results for compliance of water repellents with requirements indicated.

F. Manufacturer Technical Representative's reports.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Water Repellent Material: Two gallons of each type installed.
1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who employs only persons trained and approved by water repellent manufacturer for application of manufacturer's products.

B. Regulatory Requirements: Comply with applicable rules of pollution-control regulatory agency having jurisdiction in Project locale regarding VOCs and use of hydrocarbon solvents.

C. Manufacturer's Technical Representative:
   1. Visit site not less than three times, if required, to review technical aspects critical to clear penetrating water-repellent and graffiti control water repellent application procedures.
      a. Pre-installation meeting; Installation of mock-up.
      b. Beginning of installation for observation of substrate suitability for roofing application.
      c. Observation of completed installation.
   2. Document site visits in writing with copy to Architect.

1.05 MOCK-UP

A. See Section 01 43 39 Coordinated Mock-up for additional requirements.

B. Prepare a representative surface 36 by 36 inch in size using specified materials and preparation and application methods on surfaces identical to those to be coated; approved mock-up constitutes standard for workmanship.

C. Locate where directed.

1.06 PROJECT CONDITIONS

A. Weather and Substrate Conditions: Do not proceed with application of water repellent under any of the following conditions, except with written approval by Architect:
   1. Ambient temperature or temperature of substrate is less than 40 deg F or more than 90 deg. F.
   2. Concrete surfaces and mortar have cured for less than 28 days.
   3. Rain or temperatures below 40 deg F are predicted within 24 hours.
   4. Surfaces have been wet within the last 4 days.
   5. Substrate is frozen or surface temperature is less than 40 deg F.
   6. Windy condition exists that may cause water repellent to be blown onto vegetation or surfaces not intended to be coated.

1.07 WARRANTY

A. Special Water-Repellent Warranty: Submit a written warranty, executed by the applicator and water repellent manufacturer, covering materials and labor, agreeing to repair or replace materials that fail to provide water repellency within the specified warranty period. Warranty does not include deterioration or failure of coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new joints and cracks in excess of 1/16 inch wide, fire, vandalism, or abuse by maintenance equipment.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide all types of water repellents by a single manufacturer.

B. Subject to compliance with requirements, provide products indicated.

2.02 PENETRATING WATER REPELLANTS

A. Clay Masonry (Brick) Water Repellent: Clear, isobutyltrialkoxyxilane or silane and siloxane blend with more than 40% solids and 3.3 lb/gal. or less of VOCs:
   1. Basis of Design: Degussa, Chem-Trete BSM-40 VOC

B. Concrete Masonry Unit (CMU) Water Repellent: Clear, alkyltrialkoxyxilanes with activator or silane and siloxane blend with more than 40% solids and 3.3 lb/gal. or less of VOCs:
   1. Basis of Design: Degussa, Chem-Trete PB VOC
C. Concrete and Stucco Water Repellent: Clear, isobutyltrialkoxysilane with more than 40% solids and 3.3 lb/gal. or less of VOCs:
   1. Basis of Design: Degussa, Chem-Trete BSM-40 VOC.

D. Stone Water Repellent: Clear, isobutyltrialkoxysilane with more than 40% solids and 3.3 lb/gal. or less of VOCs:
   1. Basis of Design: Degussa, Chem-Trete BSM-40 VOC.

2.03 PENETRATING GRAFFITI CONTROL-WATER REPELLENT
A. Clear Penetrating Anti-Graffiti Coating: Penetrating fluoro-silane solution that complies with performance requirements:
   2. Fabrikem, Fabrishield Paint Repellent PR-63, penetrating blend of polymers, organo silanes and siloxanes.
   3. Prosoco, Shure Klean Weather Seal Blok-Guard & Graffiti Control,

PART 3 EXECUTION

3.01 PREPARATION
A. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to repellent manufacturer's written instructions, to ensure surface is sufficiently dry.
   1. Formed Concrete: Remove oil, curing compounds, laitance, and other substances that could prevent adhesion or penetration of water repellents.

B. Test for pH level, according to water repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.

C. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.

D. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
   1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.

E. Test Application: Before performing water-repellent work, including bulk purchase and delivery of products, prepare a small application in an unobtrusive location and in a manner approved by Architect to demonstrate the final effect (visual, physical, and chemical) of planned application. Proceed with work only after Architect approves test application or as otherwise directed.

3.02 APPLICATION
A. Comply with manufacturer's approved written instructions, unless otherwise indicated
   1. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

B. Water Repellent: Apply a heavy, full saturation coating of water repellent on surfaces indicated for treatment using low-pressure spray equipment. Start at bottom of wall and work up. Continue application until surface is fully saturated.

C. Graffiti Repellent: Apply to water repellent surfaces to top of second level above grade or above below 10 feet unless indicated otherwise.

D. Coordinate application of graffiti repellent and water repellent. Comply with Manufacturer's recommendations as approved in mock-up.

E. Exterior graffiti repellent must be applied to the top of the second level from grade or from any external staining surface as required by campus standards.

F. Coordinate application of graffiti repellent on exposed to view concrete in the "Hearth Area" and other areas as indicated.
3.03 FIELD QUALITY CONTROL
   A. Manufacturer's Field Service: Provide services of a factory-authorized technical service representative to inspect and approve the substrate before application, to instruct the applicator on the product and application method to be used, and to perform acceptance testing.
      1. Perform static pressure water penetration test, 6 inch water column, 4 hours.
      2. Test Equipment: Standard Rylon tube.
      3. Submit written report.

3.04 CLEANING
   A. Protective Coverings: Remove protective coverings from adjacent surfaces and other protected areas.
   B. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Repair damage caused by water-repellent application. Comply with manufacturer's written cleaning instructions.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Board insulation at cavity wall construction, over roof deck, over roof sheathing, and exterior wall behind brick, stone veneer, and metal panel wall finish.

B. Batt insulation in curtain walls.

C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Installation requirements for board insulation over steep slope roof sheathing or roof structure.

1.03 REFERENCE STANDARDS


J. U.S. FTC - Insulation product rating. The thermal resistance (R-value) of insulation shall be determined in accordance with the U.S. FTC R-value rule.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.


2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.

3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.

D. Manufacturer’s Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

E. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
1.05 FIELD CONDITIONS
A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

1.06 QUALITY ASSURANCE
A. Insulation Labeling: An R-value identification mark shall be applied (by manufacturer) to each piece of insulation 12 inches or greater in width.
   1. Alternately, the insulation installers have provided a signed, dated, and posted certification listed the type, manufacturer, and R-value of insulation installed.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to and not intended to limit other rights the Owner may have under Contract.
C. Warranty Period: 5 years from Date of Substantial Completion of Work.

PART 2 PRODUCTS
2.01 FOAM BOARD INSULATION MATERIALS
A. Expanded Polystyrene Board Insulation: ASTM C 578; with the following characteristics:
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
   3. Complies with fire-resistance requirements shown on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
   4. Type II, 1.35 pcf, 15.0 psi compressive strength, Type IX, 1.8 pcf, 25 psi compressive strength for under slabs.
   5. Board Size: As indicated per application.
   6. Thermal Resistance: R-Value of 4.0 minimum per inch of thickness.
   7. Board Thickness: As indicated for application.
   8. Water Absorption: 4 percent by volume, maximum, when tested in accordance with ASTM D2842.

2.02 FIBER BOARD INSULATION MATERIALS
A. Mineral Fiber Board Insulation: Rigid or semi-rigid mineral fiber, ASTM C612 or C553; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
   1. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
   2. Board Size: As indicated to meet assembly requirements.
   3. Board Thickness: As indicated for application.
   4. Thermal Resistance (R-value): 4.2 deg F sq ft/Btu at 75 degrees F, minimum, when tested according to ASTM C518.
   5. Water Vapor Permeance: 27.2 Perm minimum
   6. Manufacturers:
      a. High Density Mineral Board Insulation: ROXUL, Inc; CurtainRock 80: (8 pound density), www.rspec.com., or approved equal.
      b. Low Density Mineral Board Insulation: ROXUL, Inc; CurtainRock 80: (3.5 pound density), www.rspec.com., or approved equal.
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 BATT INSULATION MATERIALS
A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option. Where mineral fiber batt insulation is indicated, mineral fiber batt insulation must be used.
B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
   1. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
THERMAL INSULATION

2.04 SPRAY FOAM INSULATION

A. Insulating Foam Sealant:
   1. HCFC based spray applied polyurethane foam, ASTM C 1029, closed cell, minimum density 2 lb/cu.ft.
      b. Acceptable Manufacturers:
         1) DOW, Great Stuff
         2) Substitutions: See Section 01 60 00 - Product Requirements.
   2. Locations:
      a. Where board insulation does not meet or does not entirely fill cavity.
      b. Inside stud cavities surrounding openings.
      c. Roof to wall connections.
      d. Miscellaneous cavities and other locations indicated.
      e. At locations where air barrier continuity cannot be achieved with the WRB alone.
      f. At discontinuities of exterior insulation.

2.05 VAPOR RETARDER

A. Sheet Vapor Retarder: Reinforced laminated plastic, ASTM C-1136 Type II with the following characteristics:
   1. Permeance: 0.02 perm per ASTM E-96-A.
   2. Combustibility: Non-combustible when tested in accordance with ASTM E 136.
   5. Acceptable Product: Lamtec WMP-10

B. Vapor Retarder Tape: Same membrane as vapor retarder sheet, self-adhering type, mesh reinforced, 2 inch wide.

C. adhesive-Sealant: Dow Corning 795.

2.06 ACCESSORIES

A. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.

B. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.

C. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION

3.01 BOARD INSTALLATION AT EXTERIOR WALLS

A. Install insulation board directly to weather resistive barrier faced exterior sheathing as indicated with manufacturer recommended mechanical fasteners. Tape all joints with manufacturer's minimum 4 inch wide sealant tape; comply with ASTM E2357.
B. Install boards horizontally on walls.
   1. Install in running bond pattern.
   2. Butt edges and ends tightly to adjacent boards and to protrusions.
C. Extend boards over expansion joints, unbonded to wall on one side of joint.
D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.02 BOARD INSTALLATION AT CAVITY WALLS
A. Install boards to fit snugly between wall ties.
B. Install boards horizontally on walls.
C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK
A. Installation of board insulation over low slope roof deck is specified in Section 07 54 00.

3.04 BOARD INSTALLATION OVER STEEP SLOPE ROOF SHEATHING OR ROOF STRUCTURE
A. Installation of board insulation over steep slope roof structure or roof sheathing is specified in Section 06 10 00.

3.05 BATT INSTALLATION
A. Install insulation in accordance with manufacturer's instructions.
B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.06 VAPOR RETARDER INSTALLATION
A. In exterior stud-framed walls, attach sheet vapor retarder to inside stud faces with adhesive. Lap edges over stud faces, seal laps with tape. Lap ends onto adjacent construction; seal ends with sealant.
   1. Seal penetrations and openings in vapor retarder sheet to penetration or frame of opening with sealant or tape.
B. At window and door openings install sheet vapor retarder between frame and adjacent wall seal material and attach with adhesive. Seal laps with tape. Position lap seal over firm bearing.
   1. When edge of frame will be concealed, apply tape between frame and vapor retarder to form a continuous membrane integrating frame.
C. Apply sealants and adhesives within recommended application temperature ranges. Consult manufacturer temperature is out of this range.

3.07 QUALITY ASSURANCE
A. Insulation mark installation: insulating materials are to be installed such that the manufacturer's R-value mark is readily observable upon inspection.

3.08 PROTECTION
A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Weather-Resistive Barrier (WRB): Under exterior wall cladding, over sheathing or other substrate; not air tight or vapor retardant.

B. Vapor Retarders: Materials to make exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls water vapor-resistant and air tight.

C. Air Barriers: Materials that form a system to stop passage of air through exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls.

1.02 DEFINITIONS

A. Weather Barrier: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.

B. Air Barrier: Air tight barrier made of material that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces. Note: For the purposes of this specification, vapor impermeable air barriers are classified as vapor retarders.

C. Vapor Retarder: Air tight barrier made of material that is relatively water vapor impermeable, to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.

1. Water Vapor Permeance: For purposes of conversion, $57.2 \text{ ng/(Pa s sq m)} = 1 \text{ perm}$.

D. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture-resistant, to the degree specified, intended to be installed to shed water without sealed seams.

E. For Purposes of This Section:

1. Weather Barrier Assembly: A membrane with components, consisting of water vapor impermeable, water-resistive air barrier membrane, flashings, sealants and other accessories that make it a complete and fully continuous system in conformance with specified performance criteria and Design Basis product requirements when interfaced with other building envelope products and systems.

1.03 REFERENCE STANDARDS


1.04 PERFORMANCE REQUIREMENTS

A. Provide an air barrier membrane system constructed to perform as a continuous air barrier, and as a liquid water drainage plane flashed to discharge to the exterior any incidental condensation or water penetration. Membrane system shall accommodate movements of building materials by providing expansion and control joints as required, with accessory air sealant materials at such locations, changes in substrate, perimeter conditions and penetrations.
B. Air barrier membrane system shall bridge and seal the following air leakage pathways and gaps:
   1. Connections of the walls to the roof air barrier.
   2. Connections of the walls to the foundations.
   3. Seismic and expansion joints.
   4. Openings and penetrations of window and door frames, store front, curtain wall.
   5. Piping, conduit, duct and similar penetrations.
   6. Masonry ties, screws, bolts and similar penetrations.
   7. All other air leakage pathways in the building envelope.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 35 15 - LEED Certification Procedures, for LEED related requirements
C. Submit documentation from an approved independent testing laboratory certifying compliance with,
   1. the resistance to Hydrostatic Pressure,
   2. ASTM D 882 - Tensile Properties,
   3. ASTM E 84 - Class A Surface Burning Characteristics,
   4. ASTM E 96/E 96M - Test Methods for Water Vapor Transmission of Materials,
   5. ASTM E 2178 - Standard Test Method For Air Permeance of Building Materials, and
D. Submit documentation from an approved independent testing laboratory certifying the membrane meets ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers.
E. Submit manufacturers' current product data sheets, details and installation instructions for the water-resistive vapor permeable air barrier membrane components and accessories.
F. Submit samples of the following:
   1. Manufacturer's sample warranty
   2. Each Weather Barrier sheet, minimum 10 by 10 inches (254 by 254 mm)
   3. Components, minimum 12-inch (305-mm) lengths
   4. Membrane flashings and lap seam tapes
   5. Fasteners, clips, strapping and ties
   6. Sealants
G. Manufacturer's Technical Representative Reports.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of self-adhered membrane weather barrier or waterproofing membranes.
   1. Ten years of documented experience manufacturing type of product specified.
B. Installer Qualifications: Company specializing in installation of self-adhered membrane weather barrier fluid-applied roofing or waterproofing.
   1. Approved by roofing manufacturer.
   2. Five years' documented experience.
C. Source Limitation: Obtain components for air barrier assembly system from a single source manufacturer, or if not from a single manufacturer they must be approved by the air barrier manufacturer as compatible for use with manufacturer's air barrier assembly system products.
D. Manufacturer's Technical Representative:
   1. Visit site not less than three times, if required, to review technical aspects critical to weather barrier assembly application, and installation procedures.
      a. Pre-installation meeting/Installation of mock-up.
      b. Beginning of installation for observation of substrate suitability for weather barrier assembly application.
WEATHER BARRIERS

1.07 MOCK-UP
   A. Install weather barrier assembly materials in mock-up specified in Section 01 43 19.

1.08 FIELD CONDITIONS
   A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.
   B. Do not apply weather barriers to damp or wet substrates or during snow, rain, fog or mist.
   C. Verify the substrates are free of materials that could prevent barrier adhesion.

1.09 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacture of self-adhered membrane weather barrier or waterproofing membranes.
      1. Ten years of documented experience manufacturing type of product specified.
   B. Installer Qualifications: Company specializing in installation of self-adhered membrane weather barrier fluid-applied roofing or waterproofing.
      1. Approved by roofing manufacturer.
      2. Five years' documented experience.
   C. Source Limitation: Obtain components for air barrier assembly system from a single source manufacturer, or if not from a single manufacturer they must be approved by the air barrier manufacture as compatible for use with manufacturer's air barrier assembly system products.
   D. Manufacturer's Technical Representative:
      1. Visit site not less than three times, if required, to review technical aspects critical to roofing application, and installation procedures.
         a. Pre-installation meeting/Installation of mock-up.
         b. Beginning of installation for observation of substrate suitability for roofing application.
         c. Observation of completed installation.
      2. Document site visits in writing with copy to Architect.

PART 2 PRODUCTS

2.01 WEATHER BARRIER ASSEMBLY
   A. Primary weather barrier basis of design is Blueskin SA manufactured by Henry; an SBS modified bitumen self-adhering membrane. Membrane shall have the following physical properties:
      1. Air leakage: <0.004 CFM/ft² @ 1.57 lbs/ft² [<0.02L/m² @ 75Pa] when tested in accordance with ASTM E2178.
      2. Water Vapor Permeance: 0.28 perms to ASTM E96, water method.
      3. Tested to ASTM E2357 for Air Leakage of Air Barrier Assemblies.
      6. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84: Flame Spread Rating of 0 and Smoke Development Classification of 105
      7. Basis Weight: Minimum 160 gm/m², when tested in accordance with TAPPI Test Method T-410.
      8. Tensile Strength: 40 lbF MD and 29 lbF CD per ASTM D882.
      10. Cyclic and Elongation: Pass at 100 cycles, -29 degrees C (-20 degrees F) per ICC-ES AC 48.
   B. Self-adhering membrane (SAM) flashing for all window jambs, headers, door openings, inside and outside corners, and other transitions basis of design is pre-cut Blueskin WB manufactured...
by Henry; a self-adhering sheet air barrier membrane with an engineered film. Membrane shall have the following physical properties:

1. Membrane Thickness: 0.9mm (35 mils)
2. Air leakage: <0.004 CFM/ft² @ 1.57 lbs/ft² [<0.02L/m² @ 75Pa] when tested in accordance with ASTM E2178.
3. Water Vapor Permeance: 0.05 perms to ASTM E96, water method
4. Tested to ASTM E2357 for Air Leakage of Air Barrier Assemblies.
7. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84: Flame Spread Rating of 0 and Smoke Development Classification of 105.
8. Basis Weight: Minimum 160 gm/m², when tested in accordance with TAPPI Test Method T-410.
10. Average Dry Breaking Force: 127 lbF MD, and 91 lbF CD per ASTM D 5034.
11. Cyclic and Elongation: Pass at 100 cycles, -29 degrees C (-20 degrees F) per ICC-ES AC 48.

C. Self-adhering membrane (SAM) flashing for all sill flashings basis of design pre-cut Blueskin Foilskin manufactured by Henry; a self-adhering sheet air barrier membrane laminated to a glass scrim reinforced aluminum foil. Membrane shall have the following physical properties:

1. Membrane Thickness: 1.0mm (40 mils)
2. Top surface: foil scrim
3. Air leakage: <0.004 CFM/ft² @ 1.57 lbs/ft² [<0.02L/m² @ 75Pa] when tested in accordance with ASTM E2178.
4. Water Vapor Permeance: 0.05 perms to ASTM E96, water method
5. Tested to ASTM E2357 for Air Leakage of Air Barrier Assemblies.
8. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84: Flame Spread Rating of 0 and Smoke Development Classification of 105.
9. Basis Weight: Minimum 160 gm/m², when tested in accordance with TAPPI Test Method T-410.
10. Tensile Strength: 40 lbF MD and 29 lbF CD per ASTM D828.
12. Cyclic and Elongation: Pass at 100 cycles, -29 degrees C (-20 degrees F) per ICC-ES AC 48.

D. Through-wall self adhering flashing membrane basis of design is Blueskin TWF manufactured by Henry; an SBS modified bitumen, self-adhering (Yellow) sheet membrane complete with a cross-laminated high density polyethylene film. Membrane shall have the following physical properties:

1. Membrane Thickness: 0.0394 inches (40 mils)
2. Flow (ASTM D5147): Pass @ 212 degrees F
3. Puncture Resistance: 134 lbf to ASTM E 154
4. Tensile Strength (film): 5000 psi ASTM D882
5. Tear Resistance: 17lbs. MD to ASTM D1004
6. Low temperature flexibility: -22 degrees F to CGSB 37-GP-56M

E. Substitutions: See Section 01 60 00 - Product Requirements for substitution submittal procedures.

1. Substitutions must conform to the performance and Design Basis requirements specified. Conformance with
2.02 SEALANTS
   A. Polyurethane Sealant: Type as specified in Section 07 90 05. Verify compatibility of sealant with weather-resistive barrier and related self-adhered membrane.
   B. Silicone Sealant: Type as specified in Section 07 90 05. Verify compatibility of sealant with weather-resistive barrier and related self-adhered membrane.
   C. Sealant Backers: As specified in Section 07 90 05.
   D. Primers, Cleaners, and Other Sealant Materials: As recommended by sealant manufacturer, appropriate to application, and compatible with adjacent materials.

2.03 ADHESIVES
   A. Mastic Adhesive Type __: Compatible with sheet seal and substrate, thick mastic of uniform knife grade consistency; _______ manufactured by ____________.
   B. Non-Curing Adhesive Type __: Compatible with sheet seal and substrate, permanently non-curing; ______ manufactured by ______.

2.04 ACCESSORIES
   A. Thinners and Cleaners: As recommended by material manufacturer.
   B. Tapes:
      1. Weather-Resistive Barrier Tapes: Seal all laps of weather-resistive barrier to eliminate uncontrolled air leakage.
   C. Primers: Provide self-adhered flashing manufacturer's recommended primer to aid in adhesion between substrate and flashing membrane.
   D. Fasteners: As recommended by barrier manufacturer.
   E. Adhesives: As recommended by barrier manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces and conditions are ready to accept the work of this section.

3.02 PREPARATION
   A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.
   B. Clean and prime substrate surfaces to receive adhesives in accordance with manufacturer's instructions.
   C. Verify that surfaces and conditions are ready to accept the Work of this section. Notify Architect in writing of any discrepancies. Commencement of the Work or any parts thereof shall mean acceptance of the prepared substrates.
   D. All surfaces must be dry, sound, clean and free of oil, grease, dirt, excess mortar or other contaminants detrimental to the adhesion of the water resistive air barrier membrane and flashings. Fill voids and gaps in substrate greater than ¼ inch in width to provide an even surface. Strike masonry joints full-flush.
   E. Minimum application temperature self-adhered membrane and flashings to be above 20 degrees F (minus 6.0 degrees C).
   F. Ensure all preparatory Work is complete prior to applying primary self-adhered vapor permeable air barrier sheet membrane.

3.03 INSTALLATION
   A. Install materials in accordance with manufacturer's instructions.
   B. Openings and Penetrations in Exterior Weather Barriers:
      1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto weather barrier and at least 6 inches up jambs; mechanically fasten stretched edges.
2. Complete detail Work around corners, wall openings, building transitions and penetrations prior to field applications.
3. Install weather barrier membrane over the outside face of the substrate, measure and pre-cut into manageable sized sheets to suit the application conditions.
4. Install self-adhered vapor permeable air barrier sheet complete and continuous to substrate in a sequential overlapping weatherboard method starting at bottom or base of wall and working up.
5. Stagger all end lap seams.
6. Roll installed membrane with roller to ensure positive contact and adhesion with substrate.
7. At openings to be filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with at least 4 inches wide; do not seal sill flange.
8. At openings to be filled with non-flanged frames, seal weather barrier to all sides of opening framing, using flashing at least 9 inches wide, covering entire depth of framing.
9. At head of openings, install flashing under weather barrier extending at least 2 inches beyond face of jambs; seal weather barrier to flashing.
10. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
11. Service and Other Penetrations: Form flashing around penetrating item and seal to weather barrier surface.

C. Inside and Outside corners:
   1. Pre-treat inside and outside corners with primary weather barrier transition and flashing membrane extending a minimum of 5 inches from inside and outside corners, or overlap field material a minimum of 3 inches in each direction.
   2. Align and position primary weather barrier transition and flashing membrane, remove protective film and press firmly into place. Provide minimum 3 inch overlap at all side laps and minimum 3 inch overlap at all end laps of membrane.
   3. Roll membrane and lap seams with roller to ensure positive contact and adhesion.

3.04 FIELD QUALITY CONTROL
   A. Make notification when sections of work are complete to allow review prior to covering self-adhered water-resistive vapor permeable air barrier system.

3.05 PROTECTION
   A. Protect wall areas covered with weather barrier assembly from damage due to construction activities, high wind conditions, and extended exposure to inclement weather.
   B. Review condition of weather barrier assembly prior to installation of cladding. Repair, or remove and replace damaged sections with new membrane.
   C. Recommend to cap and protect exposed back-up walls against wet weather conditions during and after application of membrane, including wall openings and construction activity above completed weather barrier assembly installations.
   D. Remove and replace Water-Resistive weather barrier membrane affected by chemical spills or surfactants

END OF SECTION
PART 1   GENERAL

1.01  SECTION INCLUDES
A. Structural roofing system of preformed steel panels.
B. Thermal roof insulation.
C. Fastening system.
D. Factory finishing.
E. Accessories and miscellaneous components.

1.02  RELATED REQUIREMENTS
A. Section 07 90 05 - Joint Sealers: Field-installed sealants.

1.03  REFERENCE STANDARDS

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Summary of test results, indicating compliance with specified requirements.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Specimen warranty.
C. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
   1. Show work to be field-fabricated or field-assembled.
   2. Include structural analysis signed and sealed by qualified structural engineer, indicating conformance of roofing system to specified loading conditions.
D. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches square, representing actual roofing metal, thickness, profile, color, and texture.
   1. Include typical panel joint in sample.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit SS 7.2: Roofing surface Solar Reflectance Index (SRI).
   3. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
F. Test Reports: Indicate compliance of metal roofing system to specified requirements.
G. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in the manufacture of roofing systems similar to those required for this project.
B. Installer Qualifications: Company trained and authorized by roofing system manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Finish Warranty: Provide manufacturer's special warranty covering failure of factory-applied exterior finish on metal roof panels and agreeing to repair or replace panels that show evidence of finish degradation, including significant fading, chalking, cracking, or peeling within specified warranty period of 5 year period from date of Substantial Completion.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Design is based on Span-Lok, manufactured by AEP Span.
B. Acceptable manufacturers are:

2.02 STRUCTURAL METAL ROOF PANELS
A. Structural Metal Roofing: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for conformance to the following minimum standards:
   1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed 1/180 of the span when tested in accordance with ASTM E1592.
   2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
   3. Wind Uplift: Class 90 wind uplift resistance of UL 580.
   4. Air Infiltration: Maximum 0.06 cfm/sq ft at air pressure differential of 6.24 lbf/sq ft, when tested according to ASTM E1680.
   5. Water Penetration: No water penetration when tested according to procedures and recommended test pressures of ASTM E1646. Perform test immediately following air infiltration test.
   6. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 120 degrees F.
B. Metal Panels: Factory-formed panels with factory-applied finish.
   1. Type: Single skin, uninsulated.
   2. Steel Panels:
      a. Aluminum-zinc alloy-coated SS (structural steel) sheet conforming to ASTM A792/A792M; minimum AZ50 coating.
      b. Steel Thickness: Minimum 0.024 inch.
   3. Profile: Standing seam, with minimum 2.0 inch seam height; concealed fastener system for field seaming with special tool.
   5. Length: Full length of roof slope, without lapped horizontal joints.
   6. Width: Maximum panel coverage of 16 inches.
2.03 ATTACHMENT SYSTEM
   A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.04 PANEL FINISH
   A. Fluoropolymer Coating System: Manufacturer’s standard multi-coat thermocured coating system, including minimum 70 percent fluoropolymer color topcoat with minimum total dry film thickness of 0.9 mil; color and gloss to match sample.

2.05 ACCESSORIES AND MISCELLANEOUS ITEMS
   A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
   B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of combination steel and closed-cell foam.
   C. Sealants: As specified in Section 07 90 05.
      1. Exposed sealant must cure to rubber-like consistency.
      2. Concealed sealant must be non-hardening type.
      3. Seam sealant must be factory-applied, non-skinning, non-drying type.
   D. Thermal Insulation: Provide rigid, faced with white, flexible, non-dusting vapor retarder tested for maximum flame-spread rating of 50, per ASTM E84; for installation using spacer blocks.
      1. Isocyanurate Insulation Board: ASTM C 1289, Type II, Class 1, Grade 2, glass-fiber mat facer on both major surfaces, 48 by 48 inches.
      3. Insulation Cover Board: ASTM C 1278/C 1278M, cellulosic-fiber-reinforced, water-resistant gypsum substrate, 1/4 inch thick, USG Corporation; Securock.
      4. Insulation Thickness: As indicated.
   E. Standard Underlayment: Grace Tri-Flex 30.
   F. Waterproof Underlayment: Grace Ice and Water Shield.

2.06 FABRICATION
   A. Panels: Fabricate panels and accessory items at factory, using manufacturer’s standard processes as required to achieve specified appearance and performance requirements.
   B. Joints: Factory-install captive gaskets, sealants, or separator strips at panel joints to provide weathertight seals, eliminate metal-to-metal contact, and minimize noise from panel movements.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
   A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed roof will be free of leaks.
   B. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by roof panel manufacturer.
C. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

### 3.03 INSTALLATION

A. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer’s instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.

1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.

2. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.

B. Accessories: Install all components required for a complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.

C. Underlayment: Install standard and waterproof underlayment before installing preformed metal roof panels. Secure by methods acceptable to roof panel manufacturer, minimizing use of metal fasteners. Apply from eaves to ridge in shingle fashion, overlapping horizontal joints a minimum of 2 inches and side and end laps a minimum of 3 inches. Offset seams in building paper and seams in roofing felt.

1. Roof Pitch less than 3:12: Provide waterproof underlayment throughout.

2. Roof Pitch 3:12 and Greater: Provide waterproof underlayment at eave, rake, ridge, hip and valley as recommended by underlayment Manufacturer. Coordinate installation of standard underlayment over remainder.

D. Roof Panels: Install panels in strict accordance with manufacturer’s instructions, minimizing transverse joints except at junction with penetrations.

1. Form weathertight standing seams incorporating concealed clips, using an automatic mechanical seaming device approved by the panel manufacturer.

E. Insulation: Install insulation between roof covering and supporting members in two layers, staggered joints, to present a neat appearance. Tape seams unless otherwise approved by Architect. Install cover board over insulation.

### 3.04 CLEANING AND PROTECTION

A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

B. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.

C. Touch-up, repair, or replace damaged roof panels or accessories before date of Substantial Completion.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Manufactured metal panels for walls and soffits, with insulation, liners, related flashings, and accessory components at rainscreen wall assemblies, rooftop screen walls, curtain wall infill panels and as interior wall treatment.

1.02  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate dimensions, layout, joints, construction details, methods of anchorage.
   C. Samples: Submit two samples of each scheduled wall panel, liner panel, and/or soffit panel, 12 inch by 12 inch in size illustrating finish color, sheen, and texture.

1.03  QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
   B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience.

1.04  DELIVERY, STORAGE, AND HANDLING
   A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
   B. Store prefinished material off ground and protected from weather. Prevent twisting, bending, or abrasion, and provide ventilation to stored materials. Slope metal sheets to ensure drainage.
   C. Prevent contact with materials that may cause discoloration or staining of products.

1.05  WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective work within a five year period after Substantial Completion for degradation of panel finish, including color fading caused by exposure to weather.
   C. Correct defective Work within a five year period after Substantial Completion, including defects in water tightness and integrity of seals.
   D. Correct defective Work within a ten year period after Substantial Completion, including delaminations or other structural failures.

PART 2  PRODUCTS

2.01  MANUFACTURED METAL PANELS
   A. Wall Panel System (MP-1, MP-4, MP-5): Factory fabricated prefinished metal panel system, site assembled.
      1. Provide exterior panels, interior liner panels, soffit panels, and subgirt framing assembly.
      2. Provide exterior panels, interior liner panels, soffit panels, and delegated Design subgirt framing assembly (see Section 05 4010).
      3. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall.
      5. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
      6. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
      7. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
      8. Corners: Factory-fabricated in one continuous piece with minimum 18 inch returns.

B. Wall Panel System (MP-2): Factory fabricated prefinished metal panel system, site assembled.
   1. Provide exterior panels and subgirt framing assembly.
   2. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall.
   4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
   5. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
   6. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
   7. Corners: Factory-fabricated in one continuous piece with minimum 18 inch returns.
10. Exterior Panels:
    a. Profile: Vertical; style as indicated.
    b. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
    c. Panel Width: As indicated.

C. Soffit Panels (MP-1): As indicated on drawings.

D. Subgirts:
   1. Delegated Design, thermally broke, stainless steel (Galvanized steel G-185 at Penthouse MP-2) structural support system, see Section 05 40 10.
   2. Custom Designed profile; to attach panel system to building.

E. Internal and External Corners: Same material, thickness, and finish as exterior sheets; with profile to suit system; shop cut and factory mitered to required angles. Mitered internal corners to be back braced with 16 gage precoated sheet stock to maintain continuity of profile.

F. Expansion Joints: Same material, thickness and finish as exterior sheets; 16 gage; manufacturer's standard brake formed type, of profile to suit system.

G. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

H. Anchors: Stainless steel.

2.02 SUPPLEMENTARY COMPONENTS

A. Aluminum Composite Material (ACM) Panels:
   1. Custom Designed Profile Coping: Fabricate to detail indicated to attach above/adjacent to building panel system.
      a. Finish: Custom color matched to the curtain wall and building metal panel system.
   2. Custom size panel for incorporation into curtain wall system.
      a. Finish: Custom color to match curtain wall.

2.03 ACCESSORIES

A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.

B. Sealants: As specified in Section 07 90 05.
C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, stainless steel. Exposed fasteners same finish as panel system.

D. Matching Profile and Finish Louvers: See Section 08 91 00.

2.04 FABRICATION
A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Form pieces in longest practicable lengths.
C. Install vents as required to weep water back to exterior.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that building framing members are ready to receive panels.
B. Verify that water-resistive barrier has been installed over substrate completely and correctly.

3.02 PREPARATION
A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane. Space at intervals indicated.

3.03 INSTALLATION
A. Install panels on walls and soffits in accordance with manufacturer's instructions.
B. Fasten panels to structural supports; aligned, level, and plumb.
C. Provide expansion joints where indicated.
D. Use concealed fasteners unless otherwise approved by Architect.
E. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.04 TOLERANCES
A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.

3.05 CLEANING
A. Remove site cuttings from finish surfaces.
B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

3.06 SCHEDULE
A. MP-1
   1. Manufacturer: Rimex Stainless Steel
   2. Product: 1 inch composite panel
   3. Pattern: Cambridge
   4. Rigidized Patterns: 48 inch by 120 inch or 144 inch, 6SL
   5. Notes: Composite honeycomb with continuous clips for rainscreen system, matching flashings and closure profiles.

B. MP-2
   1. Manufacturer: Centria
   2. Product: Profile Series Prefinished Box Rib Panel, Exposed Fastener Profiles BR5-36
   3. Color: Custom Metallic Paint TBD
   4. Provide mitered corners.
   5. Provide matching Profile Series Louvers, in locations indicated on drawings
      a. Matching material and finish as adjacent panels.
      b. Blade Lengths: As indicated and as required to fit withing the metal panel layout.
      c. Blade Depth: As required.
      d. Free Area: See mechanical requirements.

C. MP-3 (NOT USED)
D. MP-4
METAL PANELS

1. Manufacturer: Rimex Stainless Steel, Rigidized Metals, or equivalent
2. Product: 1 inch composite panel
3. Pattern: Brushed Stainless Steel
4. Sheetgood: 60 inch by 120 inch
5. Notes: Composite honeycomb with continuous clips for rainscreen system, matching flashings and closure profiles. Sheet good for hollow metal door cladding and jambs, as indicated on drawings
6. Provide mitered corners

E. MP-5
1. Manufacturer: Centria liner panel L-1

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thermoplastic membrane roofing system, including all components specified.
C. Commencement of work by Contractor shall constitute acknowledgement by Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.02 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 for definition of terms related to roofing work not otherwise defined in the section.
B. LTTR: Long Term Thermal Resistance, as defined by CAN-ULC S770.

1.03 PERFORMANCE REQUIREMENTS

A. Install a watertight TPO fully adhered membrane roofing system with base flashing system and compatible components that will not permit passage of liquid water and will withstand wind loads, thermally induced movement, and exposure to weather without failure.
B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
C. Roof System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
   1. Corner Uplift Pressure: 105 lbf./sq. ft.
   2. Perimeter Uplift Pressure: 75 lbf./sq. ft.
   3. Field-of-Roof Uplift Pressure: 60 lbf./sq. ft.
D. FM Listing: Provide TPO membrane roofing system, base flashings, and component materials that meet requirements of FM 4450 and FM 4470 as part of a roofing system and that are listed in Factory Mutual's "Approved Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM markings.
   1. Roofing system shall comply with Fire/Windstorm Classification: Class 1A-90.

1.04 REFERENCE STANDARDS

A. American Society of Civil Engineers (ASCE) - ASCE 7 - Minimum Design Loads for Buildings and Other Structures, Current Revision.
B. ANSI/SPRI WD-1 "Wind Design Standard for Roofing Assemblies".
C. ASTM International (ASTM):
   5. ASTM D4601 Type II - Standard Specification for asphalt impregnated and coated glass fiber base sheets.
D. Factory Mutual (FM Global):
   1. Approval Guide.
      a. Factory Mutual Standard 4470 - Approval Standard for Class 1 Roof Covers.
      b. Loss Prevention Data Sheets 1-28, 1-29.
E. International Code Council (ICC):
H. Underwriters Laboratories (UL):
   1. TGFU R1306 - "Roofing Systems and Materials Guide".

1.05 ADMINISTRATIVE REQUIREMENTS
A. Pre-Installation Conference: Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the warranty.
   1. Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work including roofing membrane product representative.
   2. Notify Architect well in advance of meeting.

1.06 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Provide membrane manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.
      b. Technical data sheets for splice tape and adhesives.
      c. Technical data sheet for batten strips and fasteners.
      d. Technical data sheet for each insulation type.
      e. Technical data sheet for each cover board type.
      f. Technical data sheet for each type of metal edging.
      g. Technical data sheet for pavers.
      h. Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.
      i. Installation Instructions: Provide manufacturer's instructions to installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.
      j. Maintenance Instructions: Periodic inspection recommendations and maintenance procedures.
         1) Instructions shall be included detailing preventative maintenance requirements necessary on the part of the building Owner to maintain warranty and noting a list of harmful substances to be avoided which may damage the roofing membrane.
C. Shop Drawings: Provide:
   1. Roof membrane manufacturer's standard details customized for this project for all relevant conditions, including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, and drains.
   2. For tapered insulation, provide project-specific layout and dimensions for each board.
D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, materials harmful to membrane, required procedures necessary for maintenance of system warranty.

F. Specimen Warranty: Submit prior to starting work.

G. Installer Qualifications: Letter from manufacturer attesting that the roofing installer meets the specified qualifications.

H. Pre-Installation Notice: Copy to show that manufacturer's required Pre Installation Notice (PIN) has been accepted and approved by the manufacturer.

I. Executed Warranty.

J. Manufacturer's Technical Representative Reports.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that has FM Approvals approved for membrane roofing system identical to that used for this Project.

B. Installer Qualifications: Roofing installer shall have the following:
   2. Current Firestone Partners in Quality Contractor status.
   3. Current Firestone Red Shield Licensed Contractor status with Master Contractor status at least once in the last three years.
   5. Current approval, license, or authorization as applicator by the manufacturer.
   6. Fully staffed office within 100 miles of the job site.
   7. At least five years of experience in installing specified system.
   8. Capability to provide payment and performance bond to building owner.
   9. Capability to provide a payment performance bond.
  10. Firm shall have been in continuous business under the same name for a minimum of 10 years.

C. Source Limitation: Obtain components for membrane roofing system approved by roof membrane manufacturer.

D. Exterior Fire-Test Exposure: ASTM E108, Class A for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

E. Fire Resistance Ratings: Provide a Class B fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

F. Pre-installation Roof Conference: Conduct conference at Project site. Shall include:
   1. Meet with Owner, Owner’s insurer if applicable, Architect, Roof Consultant, testing and inspecting agency representative, roofing Installer, roofing system manufacturer’s representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer’s written instructions.
   3. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment and facilities needed to make progress and avoid delays.
   4. Review structural loading limitations of roof deck during and after roofing.
   5. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
   6. Review governing regulations and requirements for insurance and certificates, if applicable.
   7. Review temporary protection requirements for roofing system during and after installation.
8. Review roof observation and repair procedures after roofing installation

G. Manufacturer's Technical Representative:
   1. Visit site not less than three times, if required, to review technical aspects critical to roofing application, and installation procedures.
      a. Pre-installation meeting/Installation of mock-up.
      b. Beginning of installation for observation of substrate suitability for roofing application.
      c. Observation of completed installation.
   2. Document site visits in writing with copy to Architect.

H. FM Approvals Listing: Provide roofing, base flashings, and component materials that comply with requirements in FM Approvals 4470 as part of a roofing system, and that are listed in FM Approvals’ “RoofNav” for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
   1. FM “Accepted” assemblies will be accepted upon submittal of appropriate acceptance documentation from FM Global.

1.08 DELIVERY, STORAGE AND HANDLING
   A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.
   B. Store materials clear of ground and moisture, in a cool shaded area, and with weather protective covering.
   C. Keep combustible materials away from ignition sources.

1.09 PROJECT CONDITIONS
   A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer’s written instructions and warranty requirements.
   B. Provide tarps or plastic sheeting required to protect opened roofs and flashings and to prevent the entrance of moisture or rain water into the existing structure until new materials have been applied and roof is in a watertight condition.
   C. Have necessary waterproof canvas or plastic sheeting readily available in case of emergency. The Contractor will be held liable for any damage to building interior due to Contractor’s negligence.
   D. Roofing materials shall not be applied when water in any form (i.e., rain, dew, ice, frost, snow, etc.) is present on the deck.
   E. Roofing materials shall not be applied when dirt, dust, debris, oil, etc. is present on the deck.
   F. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
   G. End of Work Day: The roof system is to be water tight by the end of each work day, using methods as outlined in the Project Documents.

1.10 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Comply with all warranty procedures required by manufacturer, including notifications, scheduling, and inspections.
   C. Warranty: Membrane Manufacturer's Limited Warranty covering membrane, roof insulation, and other indicated components of the system, for the term indicated.
      1. Limit of Liability: No dollar limitation.
      2. Materials warranty includes roofing membrane, base flashings, roofing accessories, fasteners, substrate board, roof level insulation, cover boards, walkway products, and other components of membrane roofing system.
      3. Scope of Coverage: Repair leaks in the roofing system caused by:
         a. Ordinary wear and tear of the elements.
b. Manufacturing defect in brand materials.
c. Defective workmanship used to install these materials.
d. Warranty Period: Thirty (30) years from date of final acceptance.

D. Warranty: Installer's Limited Warranty covering system installation.
   1. Include all components of roofing system such as roof membrane base flashing, fasteners, substrate boards, and other components of roofing system.
   2. Warranty Period: Five (5) years from date of final acceptance.

PART 2 PRODUCTS

2.01 ROOFING SYSTEM DESCRIPTION

A. Roofing System: Thermoplastic Polyolefin (TPO) single-ply membrane.
   1. Membrane Attachment: Fully adhered.
   2. Comply with applicable local building code requirements.
   4. Provide assembly complying with Factory Mutual Global (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.

B. Roofing System Components: Listed in order from the top of the roof down:
   1. Membrane: Fully adhere, thickness as specified.
   2. Insulation Cover Board: Gypsum-based board, 1/2-inch thick; adhesive attached.
   3. Insulation:
      a. Maximum Board Thickness: 3-inches; use as many layers as necessary; stagger joints in adjacent layers, all layers adhered.
      b. Tapered: Slope as indicated; provide minimum R-value at thinnest point; place tapered layer on bottom.
      c. Total R Value: R-40 average
      d. Crickets: Tapered insulation of same type as specified for top layer; slope as indicated.
   4. Vapor Retarder Material:
   5. Substrate Board: Gypsum-based board,
      a. Light Weight or Insulating Concrete: 1/4-inch thick; mechanically attached to metal or concrete support deck.
      b. Metal Deck: 1/2-inch thick; Mechanically Attached.
      c. Concrete Deck: 1/4-inch thick; Fully Adhered.

2.02 TPO MEMBRANE MATERIALS

A. Roofing Membrane: thermoplastic polyolefin (TPO) reinforced with a polyester, weft-inserted scrim, complying with ASTM D6878, with the following properties:
   1. Thickness: 0.080 inch.
   5. Color:
      a. White, membrane initial Solar Reflective Index (SRI): greater than or equal to 78.
      b. Gray, see roof plans for location, with matching accessories.
      a. Roofing systems manufactured by others are acceptable provided the roofing system is completely equivalent in materials and warranty conditions and the manufacturer meets the following qualifications:
         1) Specializing in manufacturing the roofing system to be provided.
2) Minimum ten years of experience manufacturing the roofing system to be provided.
3) Able to provide a no dollar limit, single source roof system warranty that is backed by corporate assets in excess of one billion dollars.
4) ISO 9002 certified.
5) Able to provide polyisocyanurate insulation that is produced in own facilities.
6) Roofing systems manufactured by the companies listed below are acceptable provided they are completely equivalent in materials and warranty conditions:
   (a) Carlisle-SynTec Incorporated.
   (b) Johns Manville.
   (c) Substitution see Section 01 60 00 for substitution requirements.

7. Provide assembly complying with Factory Mutual Corporation (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.

2.03 AUXILIARY MEMBRANE ROOFING MATERIALS
A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
   1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
B. Bonding Adhesives: A high-strength, synthetic rubber adhesive used for bonding the membrane to various surfaces. The adhesive is applied to both the membrane and the substrate.
C. Cut Edge Sealant: A white or clear sealant used to seal cut edges of reinforced membrane.
D. Water Cut-Off Mastic: Used as a mastic to prevent moisture migration at drains, compression terminations and beneath conventional metal edging.
E. Universal Single-Ply Sealant: A 100% solids, solvent free, VOC free, one part polyether sealant that provides a weather tight seal to a variety of building materials. It is white in color and is used for general caulking such as above termination bars and metal counter flashings and at scuppers.
F. Thermoplastic One-Part Pourable Sealer: A one-part, moisture curing, elastomeric polyether sealant used to fill TPO Molded Pourable Sealant Pockets.
G. Weathered Membrane Cleaner: Used to prepare membrane for heat welding that has been exposed to the elements or to remove general construction contaminants.
H. TPO Primer: Solvent-based, low solids primer used to prepare the surface of membrane prior to application of pressure-sensitive securement strips.
I. Pressure-Sensitive Securement Strips:
J. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bar, approximately 1-inch by 1/8-inch thick; with anchors.
K. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1-inch wide by 0.05-inch thick, pre-punched.
L. Walkway Pads: Manufacturer's standard white, Factory-formed, nonporous, heavy-duty, TPO, slip-resisting, surface-textured walk pads approximately 3/16 inch thick.
M. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approval 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
N. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced TPO securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
2.04 COVER BOARD
   A. Cover Board: ASTM C1177/C1177M, glass-mat faced on both sides of board surface pre-treated with bond-improving primer, water-resistant gypsum substrate, ½-inch thick.
   1. Manufacturer: Same manufacturer as roof membrane.
   B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

2.05 ROOF INSULATION
   A. Insulation Units: ASTM C 1289, Type II; Rigid closed-cell polyisocyanurate foam board, felt or glass-fiber mat facer on both major surfaces.
   1. Produced using HC blowing agents in lieu of HCFCs, in accordance with standards mandated by the Environmental Protection Agency.
   2. Thermal Resistance: Tested for Long Term Thermal Resistance (LTTR) in accordance with CAN/ULC-S770.
   3. Compressive Strength: Nominal 20 psi per ASTM D 1621.
   4. Flame Spread: 35 or less per ASTM E 84.
   5. Unit size shall be 4-foot by 8-foot.
   6. Maximum Unit thickness shall be 3-inches.
   7. Total R Value: as indicated above.
   8. Overall thickness of insulation units shall equal that as indicated on the Drawings and as required to achieve specified slopes.
   9. Insulation units shall be installed in minimum two consecutive and separate layers, with joints of each layer offset from previous layer of insulation; unless otherwise indicated.
   B. Tapered Insulation Units (for crickets): ASTM C 1289, Type II; Rigid closed-cell polyisocyanurate foam board, felt or glass-fiber mat facer on both major surfaces.
   1. Provide factory-tapered insulation boards fabricated to finish slope of 1/4-inch per 12-inches unless otherwise indicated.
   2. Unit size shall be 4-foot by 4-foot.
   3. Produced using HC blowing agents in lieu of HCFCs, in accordance with standards mandated by the Environmental Protection Agency.
   4. Slope as indicated on the Drawings; provide minimum R-value at thinnest point; place tapered layer on bottom.
   C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to the slope of 1/4-inch per 12-inches unless otherwise indicated. Use the following materials or Tapered Insulation Units.
   1. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.
   2. Cellulosic-Fiber Board Insulation shall not exceed four feet in greatest dimension (use Tapered Insulation for applications exceeding four feet wide), unless applied as a tapered edge strip.
   D. Insulation Adhesive:
   1. Adhesive material shall meet FM I-90 (Class 4450) with approved insulation boards.
   2. Material to be supplied in pressurized cylinders with a net weight of 23 lbs. per container.
   3. Approved Manufacturers:
      c. Substitution see Section 01 60 00 for substitution requirements.

2.06 VAPOR RETARDER
   A. Glass Fiber Mat Reinforced Styrene-Butadiene-Styrene (SBS) Rubber Modified, Self-Adhesive Asphalt Sheet as follows:
   1. Manufacturer Products:
THERMOPLASTIC MEMBRANE ROOFING

a. MB Base SA, as manufactured by Firestone.

B. Self-adhering membrane composed of flexible facing material coated completely and uniformly on one side with adhesive material, formed into uniform, flexible sheets, interleaved with disposable release liner that is removed prior to application.
   1. Manufacturer Products:
      a. Carlisle Product: 725TR.

C. Vapor Barrier Primer:
   1. Manufacturer Products:
      b. Carlisle Product: CCW-702LV.

2.07 SUBSTRATE BOARD

A. Substrate Board: ASTM C1177/C1177M, glass-mat faced on both sides of board surface pre-treated with bond-improving primer, water-resistant gypsum substrate,
   1. Manufacturer:
      a. Georgia-Pacific Corporation; Dens Deck Prime Roof Board.
      b. 1/2-inch or 1/4-inch in designated areas.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening to the specific substrate panel or roof deck type.

2.08 METAL ACCESSORIES

A. Metal Roof Edging and Fascia: Continuous metal edge member serving as termination of roof membrane and retainer for metal fascia; watertight with no exposed fasteners; mounted to roof edge nailer.
   1. Wind Performance:

B. Parapet Copings:
   1. Formed Metal Copings: Galvanized steel anchor/support cleats for capping any parapet wall; watertight, maintenance free, without exposed fasteners; butt type joints with concealed splice plates; mechanically fastened as indicated; Firestone PTCF.
   2. Stone or Pre-cast Concrete Copings: As indicated.
   3. Wind Performance:
      a. At least the minimum required when tested in accordance with ANSI/SPRI ES-1 Test Method RE-3, current edition.

2.09 ACCESSORY MATERIALS

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Width: 3-1/2 inches, nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.

PART 3 INSTALLATION

3.01 GENERAL

A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.

B. Obtain all relevant instructions and maintain copies at project site for duration of installation period.

C. Do not start work until Pre-Installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.

D. Perform work using competent and properly equipped personnel.
E. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

F. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F.

G. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
   1. Protect from spills and overspray from adhesives, sealants and coatings.
   2. Particularly protect metal, glass, plastic, and painted surfaces from adhesives, and sealants within the range of wind-borne overspray.
   3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.

H. Until ready for use, keep materials in their original containers as labeled by the manufacturer.

I. Consult membrane manufacturer's instructions, container labels, and Material Safety Data Sheets (MSDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

3.02 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
   2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
   3. Verify that all curbs, wall surfaces, equipment supports, and other roof penetrations that will receive roofing materials will allow the installation of full-height flashings. Verify heights of all penetrations which are located within crickets and slope upgrades; extend penetrations where necessary.

B. FM Global Roof Inspection: Arrange for a Factory Mutual Global technical representative to inspect preparation of decks which are ready to receive new roofing to ensure preparation is within FMG parameters to obtain required FMG coverage.

C. Manufacturer’s Roof Inspection: Arrange for roofing system manufacturer’s technical personnel to inspect preparation of decks to receive roofing and general installation procedures.
   1. Notify Owner 48 hours in advance of date and time of inspection.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Verify that the specification and drawing details are workable and not in conflict with the roofing manufacturer’s recommendations and instructions; start of work constitutes acceptance of project conditions and requirements.

3.03 PREPARATION

A. Remove all of the existing roof system down to the roof deck including all existing composition base flashings. Dispose of all materials properly. Perform asbestos removal in accordance with federal, state and local regulations and dispose of waste in legal manner.
   1. At penetrations, remove all existing flashings, including lead, asphalt, mastic, etc.
   2. At walls, curbs, and other vertical and sloped surfaces, remove loose and unsecured flashings; remove mineral surfaced and coated flashings; remove excessive asphalt to provide a smooth, sound surface for new flashings.
B. Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease and other materials that may damage the membrane.
   1. Moisture includes rain, dew, ice, frost, snow, and the like.
   2. Dust and debris include dirt, oil, and other materials not inherent in the substrate.
   3. Cleaned roof substrates shall be acceptable to the manufacturer and FM Global prior to being covered by new roof system materials.

C. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecasted.

D. Inspect all substrate for irregularities and defects that prohibit the proper installation of new roofing materials. Notify the Owner of all defects for proper correction, prior to installation of new materials.

E. Prepare all surfaces and details in accordance with Manufacturer’s printed instructions and these contract documents.

F. Protect building surfaces and equipment from damage and contamination from roofing work.

G. Take appropriate measures to ensure that fumes from adhesive solvents are not drawn into the building through air intakes.

H. Fill all surface voids in the immediate substrate that are greater than 1/4 inch wide with fill material acceptable insulation to membrane manufacturer.

I. Wood Nailers: Provide wood nailers at all perimeters and other locations where indicated on the drawings, of total height matching the total thickness of insulation being used.
   1. Install with 1/8 inch gap between each length and at each change of direction.
   2. Mechanically fasten to deck to resist force of 200 lbf per linear foot.

J. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the work day or when rain is forecasted. Remove and discard temporary seals before beginning work on adjoining roofing.

3.04 SUBSTRATE BOARD INSTALLATION

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
   1. Fasten substrate board to the specific existing roof deck according to recommendations in FM Approvals’ “RoofNav” and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
   2. Fasten substrate board to the specific existing roof deck to resist uplift pressure at corners, perimeter, and field of roof according to membrane roofing system manufacturers’ written instructions.

3.05 VAPOR RETARDER INSTALLATION

A. General: Vapor Retarder is intended to be a temporary weatherproof membrane capable of withstanding hydrostatic water pressure generated by storm water during the course of construction, as well as an effective Vapor Retarder after being covered.

B. Apply product called for by the manufacturer, primer or membrane adhesive, in a single layer over area to receive Vapor Retarder according to manufacturer’s approved special application instructions.
   1. Use roller applied application at a rate of 200 ft2/gallon (4.9 m2/L 0.5gal/square 0.20L/m2).
   2. Full spray application of adhesive.

C. Fully adhere Vapor Retarder in a single layer over area to receive Vapor Retarder, side and end lapping each sheet a minimum of 2-inches and 6-inches respectively.

D. Completely press field of Vapor Retarder, side laps, and end laps with a roller; achieving full adhesion of sheet and laps. Firmly press in all T-joints with a neoprene roller.
E. Provide temporary waterproof tie-offs at the end of each work day as required; using approved materials and tie-off configuration.

F. Protect Vapor Retarder from construction related activities, traffic contaminants, excessive exposure to sun light, and debris.

G. Inspect and repair Vapor Retarder each work day until covered, as required to maintain waterproof integrity.

H. Ensure that all penetrations and edge conditions are sealed to prevent moisture and air drive into the roofing system.

3.06 INSULATION INSTALLATION

A. Install insulation in configuration and with attachment method(s) specified in PART 2, under Roof Insulation.

B. Install insulation in a manner that will not compromise the vapor retarder integrity.

C. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.

D. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.

E. Lay roof insulation in courses parallel to roof edges.

F. Install tapered insulation under area of roofing to conform to slopes indicated.

G. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2-inches or greater, install two (2) or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6-inches in each direction.
   1. Install bottom layer of insulation over Vapor Barrier using adhesive applied in continuous ½-¾-inch wide ribbon spaced 8-inches on center, or as otherwise recommended by the manufacturer for wind uplift rating.
   2. Install top layer of insulation secured to the first (bottom) layer of insulation with adhesive applied in continuous ½-¾-inch wide ribbon spaced 8-inches on center, or as otherwise recommended by the manufacturer for wind uplift rating.

H. Trim surface of insulation where necessary at roof drains and install tapered units within sumps as shown on drawings so the completed surface is flush and does not restrict flow of water.

I. Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch. Fill gaps greater than 1/4 inch with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch.

J. Cold Adhesive Attachment: Apply in accordance with membrane manufacturer's instructions and recommendations; “walk-in” and weight individual roof insulation boards to obtain maximum adhesive contact.

3.07 COVER BOARD INSTALLATION

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6-inches in each direction. Loosely butt cover boards together and adhere to the insulation assembly.
   1. Adhere cover boards according to requirements in FM Approval’s “RoofNav” for specified Windstorm Resistance Classification.
   2. Adhere cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.08 ADHERED MEMBRANE ROOFING INSTALLATION

A. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.

B. Place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing; in colder weather allow for longer relax time.
C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Lay out the membrane pieces so that field and flashing splices are shingled to shed water.

E. Apply Bonding Adhesive in accordance with the manufacturer's published instructions, to the exposed underside of the membrane and the corresponding substrate area. Do not apply Bonding Adhesive along the splice edge of the membrane to be hot air welded over the adjoining sheet. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.

1. Roll the coated membrane into the coated substrate while avoiding wrinkles. Brush down the bonded section of the membrane sheet immediately after rolling the membrane into the adhesive with a soft bristle push broom to achieve maximum contact.

2. Fold back the unbonded half of the sheet and repeat the bonding procedures.

F. Hot air weld the membrane in accordance with the manufacturer's specifications. At all splice intersections, roll the seam with a silicone roller immediately after welder crossed the membrane step-off to ensure a continuous hot air welded seam.

G. Install membrane without wrinkles and without gaps or fishmouths in seams; weld and test seams and laps in accordance with membrane manufacturer's instructions and details.

H. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).

I. Repair all seam deficiencies the same day they are discovered.

J. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete per manufacturer's instructions.

K. Adhered Membrane: Bond membrane sheet to substrate using membrane manufacturer's recommended bonding material, application rate, and procedures.

1. Do not apply bonding material to fleece backing or to seaming area of membrane.

L. Edge Securement: Secure membrane at all locations where membrane terminates or goes through an angle change greater than 2 in 12 inches using mechanical fastened reinforced perimeter fastening strips, plates, or metal edgings indicated or recommended by the roofing manufacturer.

1. Exceptions: Round pipe penetrations less than 18 inches in diameter and square penetrations less than 4 inches square.

2. Metal edging is not merely decorative; ensure anchorage of membrane as intended by roofing manufacturer.

M. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.

N. Spread sealant or mastic bed over deck drain flange at roof drains and securely seam membrane roofing in place with clamping ring.

3.09 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.

B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.

1. Follow roofing manufacturer's instructions.

C. Existing Scuppers: Remove scupper and install new scupper unless noted otherwise.

D. Scuppers: Set in sealant and secure to structure; flash as recommended by manufacturer.

E. Roofing Expansion Joints: Install as shown on drawings and as recommended by roofing manufacturer.

F. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weather tight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing membrane abuts to; extend flashing at least 8 inches high above membrane surface.
1. Use the longest practical flashing pieces.

G. Roof Drains:
1. Existing Drains: Remove all existing flashings, drain leads, roofing materials and cement from the drain; remove clamping ring.
2. Taper insulation around drain to provide smooth transition from roof surface to drain. Use specified pre-manufactured tapered insulation with facer or suitable bonding surface to achieve slope; slope not to exceed manufacturer's recommendations.
3. Position membrane, then cut a hole for roof drain to allow 1/2 to 3/4 inch of membrane to extend inside clamping ring past drain bolts.
4. Make round holes in membrane to align with clamping bolts; do not cut membrane back to bolt holes.
5. Apply sealant on top of drain bowl where clamping ring seats below the membrane.

3.10 FINISHING AND WALKWAY PAD INSTALLATION
A. Install walkways at access points to the roof, around rooftop equipment that may require maintenance, and where indicated on the drawings.
1. Use specified walkway pads unless otherwise indicated.
B. Install walkway pads in areas and in patterns as indicated on the Drawings. Weld walkway products to roof membrane surface according to roofing system manufacturer's written instructions.
C. Install walkway pads leaving minimum 3-inches/maximum 4-inch gap between edges of individual walk pads for proper drainage.
D. Cut walkway pads that occur in drainage ways to allow for unobstructed water flow.
E. If installing walkway pads over field fabricated splices or if installation within 6 inches of a splice edge cannot be avoided, adhere another layer of flashing over the splice and extending beyond the walkway pad a minimum of 6 inches on either side.

3.11 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform roof test and inspection and to prepare test reports.
C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel (i.e. not a sales person) to inspect roofing installation on completion for warranty purposes and submit report to Architect.
1. Notify Owner and Architect 48 hours in advance of date and time of inspection.
D. Perform all corrections necessary for issuance of warranty.
E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional Work with specified requirements.

3.12 CLEANING
A. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
B. Clean all contaminants generated by roofing work from building and surrounding areas, including adhesives, sealants, and coatings.
C. Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.
D. Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

3.13 PROTECTION
A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for...
deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
A. Fluid-applied membrane roofing.
B. Cant strips and other accessories.
C. Drainage panels and Protection boards.
D. Accessories.

1.02  RELATED REQUIREMENTS
A. Section 22 10 06 - Plumbing Piping Specialties: Roof drain and plumbing vent flashing flanges.

1.03  REFERENCE STANDARDS

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's data for membrane and accessory materials.
C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
D. Certificate: Certify that products meet or exceed specified requirements.
E. Manufacturer's Installation Instructions: Include standard installation instructions, acceptable installation temperature range, and procedures for unusual perimeter conditions and special procedures.
F. Manufacturer Technical Representative's reports.
G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05  QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacture of fluid-applied roofing or waterproofing membranes.
   1. Ten years of documented experience manufacturing type of product specified.
B. Installer Qualifications: Company specializing in installation of fluid-applied roofing or waterproofing.
   1. Approved by roofing manufacturer.
   2. Five years' documented experience.
C. Manufacturer's Technical Representative:
   1. Visit site not less than four times, if required, to review technical aspects critical to roofing application, and installation procedures.
      a. Pre-installation meeting.
      b. Installation of mock-up.
      c. Beginning of installation for observation of substrate suitability for roofing application.
      d. Observation of completed installation.
   2. Document site visits in writing with copy to Architect.
D. Mock-Up: Construct a mock-up consisting of 100 sq ft finished with roofing membrane, including roof drains, internal and external corners, drainage panel, base flashings, control
joints, expansion joints, counterflashings, and protective cover similar to those that will be present in the finished work.
1. Locate where directed.
2. Approved mock-up may remain as part of the work.

E. FM Approvals Listing: Provide roofing, base flashings, and component materials that comply with requirements in FM Approvals 4470 as part of a roofing system, and that are listed in FM Approvals’ “RoofNav” for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
1. FM “Accepted” assemblies will be accepted upon submittal of appropriate acceptance documentation from FM Global.

1.06 FIELD CONDITIONS
A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until cured.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer Warranty:
      a. Duration: 30 years.
      b. Thermal Warranties: 80 percent retention of original thermal value, and remain on deck withstanding 70 mph wind gusts.
C. Total System Warranties: Covers components of roof assembly, including membrane, flashing, insulation, and pavers or topping slab.
   1. Includes removal and replacement of roof components, and slab/pavers, when supplied by and installed per, Manufacturer’s requirements.
   2. Duration of membrane and flashing: 30 years (watertight condition).
   3. Duration of Insulation: 30 years (80 percent of regular thermal value).
   4. Duration of Pavers: 10 years (will not crack, split or deteriorate due to freeze-thaw).

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Hot Fluid-Applied Rubberized Asphalt Roofing Manufacturers:
B. Manufacturers in conformance with performance requirements and Design Basis specified performance criteria may apply for substitution:
   1. Henry 790-11; www.henry.com
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MEMBRANE MATERIAL
A. Single component, 100 percent solids, fully reinforced hot fluid-applied rubberized asphalt roofing, 215 mil final thickness minimum; base coat to be 90 mil minimum, top coat 120 mil minimum, with the following properties measured per applicable test methods in CAN / CGSB-37.50:
   1. Flash Point: Not less than 260 deg. C or not less than 25 deg. C above manufacturer’s maximum recommended application temperature.
   2. Cone Penetration: 110 maximum at 25 deg. C, and 200 maximum at 50 deg. C.
   3. Flow: 3 mm maximum at 60 deg. C.
   4. Toughness: Not less than 5.5 J.
   5. Ratio of Toughness to Peak Load: Not less than 0.040.
   7. Water-Vapor Permeance: 1.7 ng/Pa x s x square meter.
   8. Water Absorption: 0.35-g maximum mass gain, or 0.18-g maximum mass loss.
   9. Pinholing: None.
10. Low-Temperature Flexibility: No cracking.
11. Crack-Bridging Capability: No cracking, splitting, or loss of adhesion.
12. Viscosity Test: 2 to 15 seconds.

B. Reinforcing Fabric: Non-woven, needle-punched, spunbonded polyester fabric, 6-ounces per square yard minimum weight, or as otherwise approved by manufacturer.

2.03 ACCESSORIES

A. Flashing Sheet: 50-mil minimum thickness, uncured sheet neoprene as follows:
   1. Tensile Strength: 1400 psi minimum; ASTM D412, Die C.
   2. Elongation: 200 percent minimum; ASTM D412.
   3. Tear Resistance: 125 psi minimum; ASTM D624, Die C.

B. Primer: ASTM D 41, asphaltic primer / surface conditioner compatible with membrane.

C. Protection Layer: ASTM D5147 fiberglass reinforced, SBS modified bitumen sheet, smooth surfaced; minimum 85-mil thick, as manufactured and approved by the manufacturer.

D. Sealants and Accessories: Waterproofing manufacturer’s recommended sealants and accessories for specific use in system.

E. Metal Termination Bars: Manufacturer’s standard, predrilled stainless-steel or aluminum termination bars; approximately 1-inch x 1/8-inch thick; with anchors suitable for substrates.

F. Drainage Mat (at membrane level): Composite drainage system consisting of a three-dimensional (dimpled), crush-proof, drainage core and nonwoven, needle-punched geotextile filter fabric facing.
   1. Compressive Strength: ASTM 1621; 30,000 psf minimum.
   2. Core Flow: ASTM D4716; 24 gallons per minute per sq. foot.
   3. Fabric Flow: ASTM D4491; 18 gallons per minute per sq. foot.
      a. American Hydrotech; HydroDrain 990.
      b. Substitutions: See Section 01 60 00 - Product Requirements.

G. Expanded Polystyrene Board Insulation: ASTM C 578; with the following characteristics:
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
   3. Complies with fire-resistance requirements shown on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
   4. Type IX, 1.8 pcf, 25 psi compressive strength unders slabs and pavers
   5. Board Size: As indicated per application.
   6. Thermal Resistance: R-Value of 4.0 minimum per inch of thickness.
   7. Board Thickness: As indicated for application.
   8. Water Absorption: 4 percent by volume, maximum, when tested in accordance with ASTM D2842.

H. Precast Paver System:
   1. Roof Pavers: Precast concrete, 18 pounds per square foot minimum, and minimum compressive strength of 8,000 pounds per square inch.
      a. Size: 2 feet wide by 2 feet long by 2 inches thick.
      b. Compressive Strength: ASTM C 140, 8,000 psi average minimum.
      c. Flexural Strength: ASTM C 293, 800 psi average minimum.
      d. Water Absorption: ASTM C 140, not greater than 6 percent.
      e. Freeze/Thaw: ASTM C 67, less than 1 percent loss of dry weight after 50 cycles.
      f. Center Load: WTCL 99, minimum 1,850 pounds.
      g. Color: As selected from manufacturers standard color line.
      h. Style: TBD.
      i. Texture: TBD.
   2. Elevated Leveling Support System:
PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify substrate surfaces are free of existing .
C. Verify substrate surfaces are free of failed membrane, frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of roofing system.
D. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of roofing materials.
E. Verify that roof drains and items that penetrate roof application surfaces are securely installed.

3.02 PREPARATION

A. Clean and prepare surfaces to receive roofing in accordance with manufacturer’s instructions and recommendations. Do not proceed with work until roofing manufacturer’s technical representative has approved of substrate conditions in writing.
B. Seal cracks and non-moving open joints less than 1/2 inch wide with sealant using methods recommended by roofing and sealant manufacturers. Do not seal expansion joints or moving joints of any width.
C. Install cant strips at inside corners, where indicated and where required by roofing manufacturer.
D. Protect adjacent surfaces not designated to receive roofing.

3.03 INSTALLATION

A. Apply roofing in accordance with manufacturer’s instructions and recommendations, to specified minimum thickness.
B. Do not apply roofing to surfaces unacceptable to manufacturer.
C. Apply primer or surface conditioner at a rate recommended by manufacturer. Protect conditioner from rain or frost until dry.
D. Over Sealant-Filled Joints and Cracks: Install an extra coat of roofing membrane over joint and to minimum of 6 inches each side of joint.
E. Penetrations: Unless otherwise indicated on the drawings, or otherwise recommended by roofing manufacturer, seal flexible flashing sheet around penetration and to substrate prior to installation of roofing membrane, embedding sheet in one coat of roof membrane material.
F. Embedded Flexible Flashing Sheet: Apply full thickness of roofing membrane over exposed sheet.
G. Roof Drains: Unless otherwise recommended by roofing manufacturer, set drain flange in one coat of roofing membrane and extend full thickness roofing membrane into drain clamp flange, with adequate coating of liquid membrane to ensure waterproof seal of clamp ring.
H. Coordinate with roof drain installation in plumbing section.
I. Apply extra thickness of roofing material at corners, intersections, and angles, when recommended by roofing manufacturer.
J. Install counterflashing over exposed edges, where indicated on the drawings.
K. Install drainage mat, insulation and paver/pedestal system.
3.04 FIELD QUALITY CONTROL

A. On completion of horizontal membrane installation, dam installation area in preparation for flood testing.
B. Flood to minimum depth of 1 inch with clean water. After 72 hours, inspect for leaks.
C. If leaking is found, remove water, repair leaking areas with new roofing materials as directed by Architect; repeat flood test. Repair damage to building.
D. When area is proven watertight, drain water and remove dam.

3.05 PROTECTION

A. Protect installed roofing and flashings from construction operations.
B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fabricated sheet metal items, including flashings, counterflashings, gutters, downspouts, sheet metal roofing, and other items indicated in Schedule.

1.02 REFERENCE STANDARDS
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
F. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 33 16 - Delegated Design Procedures.
C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
   1. Three dimensional axonometric views of flashings, pans and sheet metal details.
D. Samples: Submit two samples 12 x 12 inch in size illustrating metal finish color.

1.04 QUALITY ASSURANCE
A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.
B. Maintain one copy of each document on site.
C. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 10 years of documented experience.

1.05 PRE-INSTALLATION CONFERENCE
A. Convene one week before starting work of this section.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
B. Prevent contact with materials that could cause discoloration or staining.

1.07 DOWNSPOUT PERFORMANCE PARAMETERS
A. Sized for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA Architectural Sheet Metal Manual with the following parameters:
   1. Design in accordance with this section and for any additional locations per the contract documents.

PART 2 PRODUCTS

2.01 SHEET MATERIALS
A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 0.02 inch thick base metal, shop pre-coated with modified silicone coating.
1. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; custom color to match approved sample for Sections 08 44 13 - Aluminum Curtain Wall, 07 42 13 - Metal Panels, and 07 41 13 - Metal Roof Panels.

B. Stainless Steel: ASTM A666 Type 304, soft temper, 0.015 inch thick; smooth No. 4 finish.

2.02 ACCESSORIES

A. Fasteners: Stainless steel, with soft neoprene washers.
B. Underlayment: ASTM D2178, glass fiber roofing felt.
C. Flexible Flashing Underlayment: Product specified in Section 07 25 00 or 07 27 00.
D. Slip Sheet: Rosin sized building paper.
E. Primer: Zinc chromate type.
F. Protective Backing Paint: Zinc molybdate alkyd.
G. Sealant: Silicone type as specified in Section 07 90 05.
H. Plastic Cement: ASTM D4586, Type I.
I. Reglets: Recessed type, galvanized steel; face and ends covered with plastic tape.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Form pieces in longest possible lengths, except where noted otherwise.
C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
F. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.04 ROOF PENETRATIONS

A. Comply with NRCA and SMACNA requirements.
B. Roof Drains and Vents: Lead.
C. Posts, pipes, and Conduit: Prefinished galvanized steel cone shape and counter flashing with draw-band and top sealant channel.
D. Equipment Pads: Galvanized steel.

2.05 GUTTER AND DOWNSPOUT FABRICATION

A. Gutters: Profile as indicated.
B. Downspouts: Profile as indicated.
C. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA Architectural Sheet Metal Manual.
D. Accessories: Profiled to suit gutters and downspouts.
   1. Anchorage Devices: In accordance with SMACNA requirements.
   2. Gutter Supports: Brackets.
   3. Downspout Supports: Brackets.
E. Downspout Boots: Cast iron.
F. Seal metal joints.
2.06 METAL CANOPY ROOF

A. Performance Requirements: Provide complete engineered system complying with specified requirements and capable of remaining weather tight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.

B. Metal Roofing: Factory-formed panels with factory-applied finish.
   1. Zinc-coated steel conforming to ASTM A 653/A 653M; minimum G60 galvanizing.
   2. Steel Thickness: Minimum 0.0358 inch.
   3. Profile: Deep Fluted Ribs as shown and as required to span; mechanically fasten to canopy.
   5. Length: Full length of canopy slope, without lapped horizontal joints.
   6. Width: Maximum panel coverage of 24 inches.

C. Finish: Fluoropolymer Coating System: Manufacturer's standard multi-coat thermocured coating system, including minimum 70 percent fluoropolymer color topcoat with minimum total dry film thickness of 0.9 mil; color and gloss to match sample.

D. Miscellaneous Sheet Metal Items: Provide flashings, trim, closure strips, and caps of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.

E. Sealants: As specified in Section 07 90 02 Joint Sealers.
   1. Exposed sealant must cure to rubber-like consistency.
   2. Concealed sealant must be non-hardening type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION

A. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

B. Apply plastic cement compound between metal flashings and felt flashings.

C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

D. Seal metal joints watertight.

E. Secure gutters and downspouts in place using concealed fasteners.

F. Slope gutters 1/8 inch per foot minimum, unless indicated otherwise.

G. Connect downspouts to downspout boots. Grout connection watertight.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

3.05 SCHEDULE

A. Trim and Through-Wall Flashing in Siding
   1. Thickness: 0.0239 inch
2. Finish: Preprimed for field finish

B. Gutters, Downspouts, and Scuppers
   1. Thickness: 0.0239 inch
   2. Finish: Prefinished

C. Coping, Cap, Parapet, Sill and Fascia Flashings:
   1. Thickness: 0.0396 inch
   2. Finish: Prefinished in two separate custom colors

D. Flashings Associated with all other types of Roofing
   1. Thickness: 0.0239 inch
   2. Finish: Prefinished in custom color.

E. Sheet Metal Roof Expansion Joint Covers
   1. Thickness: 0.0239 inch
   2. Finish: Preprimed for field finish

F. Metal Canopy Roof
   1. Thickness: as required to structurally span areas indicated.
   2. Finish: Prefinished in custom color.

G. Curtain Wall Coping, Cap, Parapet Flashings:
   1. Thickness: 0.0418 inch
   2. Stainless Steel

H. Sill Flashing at Precast Copings
   1. Thickness: 0.0418 inch
   2. Stainless Steel

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Manufactured curbs, equipment rails, and pedestals.
B. Roof hatches.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used.
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Maintenance requirements.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 MANUFACTURED CURBS
A. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies:
   3. Roof Products & Systems (RPS) by Commercial Products Group of Hart & Cooley, Inc:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies:
   Factory-assembled hollow sheet metal construction with fully mitered and welded corners,
   integral counterflashing, internal reinforcing, and top side and edges formed to shed water.
   1. Sheet Metal: Hot-dip aluminum zinc alloy coated steel sheet (Galvalume) complying with
      ASTM A792/A792M; AZ55 coating designation; 18 gage, 0.048 inch thick.
   2. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at
      top of roofing insulation; 1:1 slope; minimum cant height 4 inches.
   3. Manufacture curb bottom and mounting flanges for installation directly on roof deck, not
      on insulation; match slope and configuration of roof deck.
   4. Provide the layouts and configurations shown on the drawings.
C. Curbs Adjacent to Roof Openings: Provide curb on all sides of opening, with top of curb
   horizontal for equipment mounting.
   1. Provide preservative treated wood nailers along top of curb.
   2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
   3. Height Above Finished Roof Surface: 6 inches, minimum.
   4. Height Above Roof Deck: 14 inches, minimum.
D. Pipe, Duct, and Conduit Mounting Pedestals: Vertical posts, minimum 8 inches square unless
   otherwise indicated.
   1. Provide sliding channel welded along top edge with adjustable height steel bracket,
      manufactured to fit item supported.
   2. Height Above Finished Roof Surface: 6 inches, minimum.
   3. Height Above Roof Deck: 14 inches, minimum.

2.02 ROOF HATCHES
A. Manufacturers - Roof Hatches:
ROOF ACCESSORIES

1. Bilco Co.: www.bilco.com
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Roof Hatches: Factory-assembled steel frame and cover, complete with operating and release hardware.
   1. Style: Provide flat metal covers unless otherwise indicated.
   2. Mounting: Provide frames and curbs suitable for mounting on flat roof deck.
   3. Size(s): As indicated on drawings; single-leaf style unless indicated as double-leaf.
   5. For Ships Ladder Access: Single leaf; 30 by 54 inches.

C. Frames/Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
   1. Material: Galvanized steel, 14 gage, 0.0747 inch thick.
   3. Insulation: 1 inch rigid glass fiber, located on outside face of curb.
   4. Curb Height: 12 inches from finished surface of roof, minimum.

D. Metal Covers: Flush, insulated, hollow metal construction.
   1. Capable of supporting 40 psf live load.
   2. Material: Galvanized steel; outer cover 14 gage, 0.0747 inch thick, liner 22 gage, 0.03 inch thick.
   4. Insulation: 1 inch rigid glass fiber.
   5. Gasket: Neoprene, continuous around cover perimeter.

E. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
   1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.
   2. Hinges: Heavy duty pintle type.
   3. Hold open arm with vinyl-coated handle for manual release.

2.03 LADDER SAFETY POST

A. Manufacturers - Roof Hatches:
   1. Bilco Co. Model LU-1: www.bilco.com
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Furnish and install at roof access a ships ladder in 4th floor stair (see Section 05 50 00)

C. Performance characteristics:
   1. Tubular post shall lock automatically when fully extended.
   2. Safety post shall have controlled upward and downward movement.
   3. Release lever shall disengage the post to allow it to be returned to its lowered position.
   4. Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14” on center and clamp brackets to accommodate ladder rungs up to 1-3/4” in diameter.

D. Post: Shall be manufactured of high strength square tubing. A pull up loop shall be provided at the upper end of the post to facilitate raising the post.

E. Material of construction: Shall be steel.

F. Balancing spring: A stainless steel spring balancing mechanism shall be provided to provide smooth, easy, controlled operation when raising and lowering the safety post.

G. Hardware: All mounting hardware shall be Type 316 stainless steel.
H. Finishes: Factory finish shall be yellow powder coat steel.

2.04 HATCH RAIL SYSTEM

A. Manufacturers - Roof Hatch Rail System:
   1. Bilco Co.: www.bilco.com
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Furnish and install where indicated on plans hatch rail system Model RL-SSW. The hatch rail system shall be field assembled and installed per the manufacturer's instructions.

C. Performance Requirements:
   1. Hatch rail system shall attach to the cap flashing of the roof hatch and shall not penetrate roofing material.
   2. Hatch rail system shall satisfy the requirements of OSHA 29 CFR 1910.23 and shall meet OSHA strength requirements with a factor of safety of two.
   3. UV and corrosion resistant construction with a twenty-five year warranty.
   4. Self-closing gate shall be provided with hatch rail system.

D. Posts and Rails: Shall be round pultruded reinforced fire retardant safety yellow colored fiberglass treated with a UV inhibitor.

E. Hardware: Mounting brackets shall be ¼" thick hot dip galvanized steel. Hinges and post guides shall be 6063T5 aluminum. Fasteners shall be Type 316 stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 GENERAL  

1.01 SECTION INCLUDES  
A. Delegated design fireproofing of interior structural steel.

1.02 REFERENCE STANDARDS  

1.03 SUBMITTALS  
A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.  
B. Product Data: Provide data indicating product characteristics.  
C. Test Reports: Reports from reputable independent testing agencies for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, for:  
   1. Bond Strength.  
   2. Bond Impact.  
   3. Compressive Strength.  
   4. Fire tests using substrate materials similar those on project.  
D. Manufacturer’s Installation Instructions: Indicate special procedures.  
E. Manufacturer’s Certificate: Certify that sprayed-on fireproofing products meet or exceed requirements of contract documents.  
F. Manufacturer’s Field Reports: Indicate environmental conditions under which fireproofing materials were installed.

1.04 QUALITY ASSURANCE  
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.  
B. Installer Qualifications: Company specializing in performing work of the type specified in this section, and:  
   1. Having minimum five years of documented experience.  
   2. Approved by manufacturer.

1.05 MOCK-UP  
A. Construct mock-up, 100 square feet in size.  
B. Conform to project requirements for fire ratings.  
C. Locate where directed.  
D. Examine installation within one hour of application to determine variances from specified requirements due to shrinkage, temperature, and humidity.  
E. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary. Remove materials and re-construct mock-up.  
F. Mock-up may remain as part of the Work.
1.06 FIELD CONDITIONS
A. Do not apply spray fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
C. Provide temporary enclosure to prevent spray from contaminating air.
D. Do not allow roof traffic during installation of roof fireproofing and drying period.

1.07 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a five year period after Date of Substantial Completion.
   1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
   2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Sprayed-On Fireproofing:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FIREPROOFING ASSEMBLIES
A. Provide assemblies as indicated on the drawings.

2.03 MATERIALS
A. Sprayed Fire-Resistive Material for Interior Applications: Manufacturer's standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance, and conforming to the following requirements:
   1. Bond Strength: 150 pounds per square foot, minimum, when tested in accordance with ASTM E736 when set and dry.
   2. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760.
   3. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937.
   4. Surface Burning Characteristics: Maximum flame spread of 0 and maximum smoke developed of 0, when tested in accordance with ASTM E84.
   5. Products:

B. Low Density Sprayed Fire-Resistive Material: Factory mixed, cementitious material blended for uniform texture with vermiculite or lightweight synthetic aggregate, and conforming to the following requirements:
   1. Bond Strength: ASTM E 736, 200 psf when set and dry.
   2. Bond Impact: ASTM E 760, no cracking, flaking or delamination.
   3. Dry Density: ASTM E 605, minimum average density of 14 lb/cu ft, with minimum individual density of any test sample of 13 lb/cu ft.
   4. Compressive Strength: ASTM E 761, minimum 7.0 psi.
   5. Surface Burning Characteristics: Maximum flame spread of 0 and maximum smoke developed of 0, when tested in accordance with ASTM E 84.

C. Medium Density Sprayed Fire-Resistive Material: For buildings of elevation 75 feet and higher, factory mixed, cementitious material blended for uniform texture with vermiculite or lightweight synthetic aggregate, and conforming to the following requirements:
   1. Bond Strength: ASTM E 736, 430 psf when set and dry.
   2. Bond Impact: ASTM E 760, no cracking, flaking or delamination.
3. Dry Density: ASTM E 605, minimum average density of 21 lb/cu ft, with minimum individual density of any test sample of 20 lb/cu ft.
5. Surface Burning Characteristics: Maximum flame spread of 0 and maximum smoke developed of 0, when tested in accordance with ASTM E 84.

2.04 ACCESSORIES
A. Primer Adhesive: Of type recommended by fireproofing manufacturer.
B. Overcoat: As recommended by manufacturer of fireproofing material.
C. Metal Lath: Expanded metal lath; 3.4 lb/sq ft, galvanized finish.
D. Water: Clean, potable.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that surfaces are ready to receive fireproofing.
B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
D. Verify that voids and cracks in substrate have been filled. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION
A. Perform tests as recommended by fireproofing manufacturer in situations where adhesion of fireproofing to substrate is in question.
B. Remove incompatible materials that could affect bond by scraping, brushing, scrubbing, or sandblasting.
C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
D. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.
E. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION
A. Install metal lath over structural members as indicated or as required by UL Assembly Design Numbers.
B. Apply primer adhesive in accordance with manufacturer’s instructions.
C. Apply fireproofing in thickness and density necessary to achieve required ratings, with uniform density and texture.
D. Apply fireproofing in sufficient thickness to achieve required ratings, with as many passes as necessary to cover with monolithic blanket of uniform density and texture.
E. Apply overcoat to a thickness required for the commensurate for rated protection requirements when required.

3.04 FIELD QUALITY CONTROL
A. Inspect the installed fireproofing after application and curing for integrity, prior to its concealment. Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings and requirements of the Authority Having Jurisdiction.
B. Re-inspect the installed fireproofing for integrity of fire protection, after installation of subsequent Work.
3.05 CLEANING
   A. Remove excess material, overspray, droppings, and debris.
   B. Remove fireproofing from materials and surfaces not required to be fireproofed.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thin-film intumescent fire-resistive coatings for exposed structural steel.
B. Protective and/or decorative topcoats.

1.02 REFERENCE STANDARDS

B. SSPC-PA 2 - Measurement of Dry Coating Thickness with Magnetic Gages; 2012.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Performance characteristics and test results.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.
C. Selection Samples: For decorative top coat, color chips representing manufacturer's full range of available colors and sheens.
D. Verification Samples: For each thickness, color, sheen, and finish required, samples not less than 4 inches square on steel substrate, illustrating finished appearance.
E. Test Reports: Published fire-resistive designs for structural elements of the types required for the project, indicating hourly ratings of each assembly.
F. Certificates: Certify that intumescent fireproofing provided for this project meets or exceeds specified requirements in all respects.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company that specializes in manufacturing the type of products specified, with minimum of 10 years of documented experience.
B. Installer Qualifications: Approved, certified, or supervised by manufacturer of intumescent fireproofing, with not less than 5 years of documented experience.
C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship. Approved mock-up will serve as a standard of comparison for subsequent work of this section.
   1. Finish at least 100 sq ft of steel in areas designated by Architect.
   2. Evaluate mock-up for compliance with specified requirements, including thickness and finish texture.
   3. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   4. Refinish mock-up area as required to produce acceptable work.
   5. Approved mock-up may remain as part of the project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers with identification labels and testing agency markings intact and legible.
B. Store products in manufacturer's unopened packaging until ready for installation.
   1. Store at temperatures not less than 50 degrees F in dry, protected area.
   2. Protect from freezing, and do not store in direct sunlight.
   3. Dispose of any materials that have come into contact with contaminants of any kind prior to application.
C. Dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
1.06 FIELD CONDITIONS
A. Protect areas of application from windblown dust and rain.
B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer’s absolute limits.
   1. Provide temporary enclosures as required to control environmental conditions.
   2. Do not apply intumescent fireproofing when ambient temperatures are below 50 degrees F without specific approval from manufacturer.
   3. Maintain relative humidity between 40 and 60 percent in areas of application.
   4. Maintain ventilation in enclosed spaces during application and for not less than 72 hours afterward.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Intumescent Fireproofing:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SYSTEM REQUIREMENTS
A. Fireproofing: Provide intumescent thin-film fire-resistive coating systems tested by an independent testing agency in accordance with ASTM E119 and acceptable to authorities having jurisdiction.

2.03 MATERIALS
A. Fire-Resistive Coating System: Thin film intumescent coating system for the fire protection of structural steel.
   1. For Interior Use:
      a. Isolatek International: CAFCO SprayFilm WB5.
   B. Sealers and Primer: As required by tested and listed assemblies, and as recommended by fireproofing manufacturer to suit specific substrate conditions.

PART 3 EXECUTION
3.01 EXAMINATION
A. Examine substrates to determine if they are in satisfactory condition to receive intumescent fireproofing. Verify that they are clean and free of oil, grease, incompatible primers, or other foreign substances capable of impairing bond to fireproofing system.
B. Do not begin installation until substrates have been properly prepared. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
A. Thoroughly clean surfaces to receive fireproofing.
B. Repair substrates to remove surface imperfections that could affect uniformity of texture and thickness of fireproofing system. Remove minor projections and fill voids that could telegraph through the finished work.
C. Cover or otherwise protect other work that might be damaged by fallout or overspray of fireproofing system. Provide temporary enclosures as necessary to confine operations and maintain required environmental conditions.

3.03 INSTALLATION
A. Comply with manufacturer’s instructions for particular conditions of installation in each case.
B. Apply manufacturer’s recommended primer to required coating thickness.
C. Apply fireproofing to full thickness over entire area of each substrate to be protected. Apply coats at manufacturer’s recommended rate to achieve dry film thickness required for fire resistance ratings designated for each condition.

D. Apply intumescent fireproofing by spraying to maximum extent possible. If necessary, complete coverage by roller application or other method acceptable to manufacturer.

E. Achieve uniform finished appearance complying with approved mock-up.

3.04 FIELD QUALITY CONTROL
A. Perform field inspection and testing in accordance with Section 01 40 00.
   1. Arrange for testing of installed intumescent fireproofing by an independent testing laboratory using magnetic thickness gage, in accordance with SSPC-PA 2.
   2. Submit test reports promptly to Contractor and Architect.
B. Repair or replace fireproofing at locations where test results indicate fireproofing does not meet specified requirements.

3.05 CLEANING
A. Immediately after installation of fireproofing in each area, remove overspray and fallout from other surfaces and clean soiled areas.

3.06 PROTECTION
A. Protect installed intumescent fireproofing from damage due to subsequent construction activities, so fireproofing is without damage or deterioration at time of Substantial Completion.
B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Delegated design firestopping systems.
B. Firestopping of all penetrations, perimeters and interruptions to fire rated assemblies, whether indicated on drawings or not, and other openings indicated.
C. See drawings and listed appeals, if applicable, for additional firestopping requirements.
D. Sleeves with integral firestopping.

1.02 REFERENCE STANDARDS
F. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.
J. IAS AC291 Accreditation Criteria for Special Inspection Agencies
K. NFPA 221 Fire Walls and Fire Barriers
L. NFPA 251 Fire Tests of Building Construction and Materials
M. OHSU- Fire-Barrier Access Permit (BAP) Procedures.
N. IAS AC291

1.03 DEFINITIONS
A. "F" RATING: A rating usually expressed in hours indicating a specific length of time that a firestop system has been tested to withstand the passage of fire. A successful hose stream test is also required.
B. "T" RATING: A rating usually expressed in hours indicating the length of time that the temperature on the non-fire side of a fire-rated assembly does not exceed 325°F above ambient temperature.
C. "L" RATING: Amount of air leakage through a penetration, measured in cubic feet per minute. The test is administered at ambient and 400°F for validity due to variances in performance of firestop systems at different temperatures.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Schedule of Firestopping: List each type of penetration.
C. Product Data: Provide data on product characteristics.
D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
F. Qualification statements for installing mechanics.
G. Engineering Judgements
   1. Where there is no specific third party tested and classified firestop system available for a particular firestop configuration, the firestopping contractor shall obtain from the firestop
FIRESTOPPING

manufacturer and Engineering Judgement (EJ) or Equivalent Fire resistance Rated Assembly (EFRRA) for submittal.

1.05 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the specified fire ratings when tested in accordance with methods indicated.
   1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.
   1. Provide all project firestopping products from a single manufacturer.

C. Installer Qualifications: Company specializing in performing the work of this section and:
   1. A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
      a. FM or UL Qualified installers shall submit certification (at bid time)showing certification from UL or FM that they have maintained their listing through their last two consecutive field audits.
   2. Able to show at least 10 satisfactorily completed projects of comparable size and type.
   3. Licensed or approved by authority having jurisdiction, where applicable.

D. Installing Mechanic's Qualifications: Trained and certified by firestopping manufacturer and able to provide evidence thereof.

E. 3rd Party inspector to meet the certification criteria set forth by IAS AC291.

F. Pre-Installation Conference: Include AHJ inspector and 3rd party inspector.

G. General contractor to hire 3rd party inspector to inspect all firestopping on the project, prior to bid to reserve funding for this quality control item.

H. All firestopping to be sourced from one manufacturer, but competitively bid.

I. All firestopping installation to be performed by one sub-contractor.

J. Electrical and low-voltage penetrations through fire rated construction not to exceed 2/3 manufacturer recommended maximum allowed fill rate of penetration - to allow for future expansion.

K. Provide Schedule of Firestopping to all trades prior to the start of work to guide the preparation of the joint, or penetration of all rated barriers.

1.06 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.
   1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.

B. If accepted, mock-up will represent minimum standard for the Work.

C. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.07 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

B. Do not install work until work area is dry and moisture will not be present for at least 3 days.

PART 2 PRODUCTS

2.01 FIRESTOPPING - GENERAL REQUIREMENTS

A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.
2.02 MANUFACTURERS

A. Provide products that comply with requirements from a single manufacturer, one of the following:
   2. Hilti, Inc.
   3. 3M Fire Protection Products Division

2.03 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.
   1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E 814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.

2.04 MATERIALS

A. Performance Criteria
   1. Provide products that upon curing do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
   2. When intumescent products are used, provide products that do not contain sodium silicate or any other water soluble intumescent ingredient in the formulation.
   3. Provide firestop products that do not contain ethylene glycol.
   4. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
   5. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
   6. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur. Such devices shall be:
      a. Capable of retrofit around existing cables
      b. Designed such that two or more devices can be ganged together
      c. Maintenance free such that no action is required to activate the smoke and fire sealing mechanism
   7. When mechanical cable pathways are not practical, openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with re-enterable products specifically designed for retrofit.
   8. Provide fire-resistive joint sealants sufficiently flexible to accommodate movement such as thermal expansion and other normal building movement without damage to the seal.
   9. Provide fire-resistive joint sealants designed to accommodate a specific range of movement and tested for this purpose in accordance with a cyclic movement test criteria as outlined in Standards, ASTM E1966, or ANSI/ UL 2079.
10. Provide penetration firestop systems, fire-resistive joint systems, or perimeter fire barrier systems subjected to an air leakage test conducted in accordance with Standard, ANSI/ UL1479 for penetrations and ANSI/UL2079 for joint systems with published L-Ratings for ambient and elevated temperatures as evidence of the ability of firestop system to restrict the movement of smoke.
11. Provide T-Rating Collar Devices tested in accordance with ASTM E814 or ANSI/UL1479 for metallic pipe penetrations requiring T-Ratings per the applicable building code.
12. Provide a fire-rated grommet for all individual or small grouped cable applications up to 0.53 in. (14 mm).
13. Provide moisture-curing products where inclement weather or greater than transient water exposure is expected.
14. All penetrations for pipes, conduits, tubing or other building service elements shall be installed below the head-of-wall joint such that the distance between the top of the wall and the top of the penetrant is a minimum of 3” (76mm). No exceptions.

15. Provide fire rated pathway sleeves with integral firestopping to provided rated wall penetrations complying with tested assembly designs.

B. Firestopping Materials Acceptable for Use:

1. General: Use only firestopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type or joint opening width and movement capabilities, annular space requirements, and fire-rating involved for each separate instance.
   a. Intumescent Sealants: Single component intumescent latex formulations containing no water soluble intumescent ingredients capable of expanding a minimum 8 times.
   b.
   c. Specified Technologies, Inc. (STI) SpecSeal Series LCI Intumescent Sealant

2. Endothermic Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture.
   a. Specified Technologies, Inc. (STI) SpecSeal Series LC Endothermic Sealant

3. Elastomeric Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture and accommodate minimum ±25 percent movement.
   a. Specified Technologies, Inc. (STI) SpecSeal Series AS Elastomeric Spray
   b. Specified Technologies, Inc. (STI) SpecSeal Series ES Elastomeric Sealant

4. Firestop Devices: Factory-assembled steel collars lined with intumescent material capable of expanding a minimum 30 times sized to fit specific outside diameter of penetrating item.
   a. Specified Technologies, Inc. (STI) SpecSeal Series SSC Firestop Collars
   b. Specified Technologies, Inc. (STI) SpecSeal Series LCC Firestop Collars

5. Fire Rated Cable Pathways: Gangable device modules capable of being retrofitted around existing cables and comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill and requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage ratings,
   a. Specified Technologies Inc. (STI) EZ-Path Fire Rated Pathway

6. Wall Opening Protective Materials: Intumescent, non-curing pads or inserts for protection of electrical switch and receptacle boxes to reduce horizontal separation to less than 24" (610 mm),
   a. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty Pads
   b. Specified Technologies, Inc. (STI) SpecSeal Series EP PowerShield Insert Pads

7. Firestop Putty: Intumescent, non-hardening, water resistant, butyl rubber based putties containing no solvents, inorganic fibers or silicone compounds,
   a. Specified Technologies, Inc. (STI) SpecSeal Series SSP Firestop Putty

8. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film and capable of expanding a minimum 30 times,
   a. Specified Technologies, Inc. (STI) SpecSeal Series RED2 Wrap Strip
   b. Specified Technologies, Inc. (STI) SpecSeal Series BLU2 Wrap Strip

9. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar,
   a. Specified Technologies, Inc. (STI) SpecSeal Series SSM Firestop Mortar

10. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag),
    a. Specified Technologies, Inc. (STI) SpecSeal SIL300 Silicone Firestop Sealant
    b. Specified Technologies, Inc. (STI) SpecSeal SIL300 SL Self-Leveling Silicone Firestop Sealant

11. All-Weather Coatings: Moisture curing, single component silicone copolymer elastomeric spray coatings for horizontal surfaces where greater water resistance is required or inclement weather is anticipated,
    a. Specified Technologies, Inc. (STI) SpecSeal FT305 Firestop Spray
12. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam,
   a. Specified Technologies, Inc. (STI) Pensil 200 Silicone Foam

13. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil capable of sustaining a minimum 2,500 lbs (1,134 kg) when subjected to load testing,
   a. Specified Technologies, Inc. (STI) SpecSeal CS Composite Sheet

14. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket,
   a. Specified Technologies, Inc. (STI) SpecSeal CD Cast-In Firestop Device

15. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use on steel HVAC ducts,
   a. Specified Technologies, Inc. (STI) SpecSeal FyreFlange Firestop Angles

16. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material capable of expanding minimum 10 times with expansion beginning at 350°F (177°C) for use in blank openings and cable sleeves,
   a. Specified Technologies, Inc. (STI) SpecSeal Series FP Firestop Plug

17. Fire-Rated T Rating Collar Device: Louvered steel collar system with synthetic aluminized polymer coolant wrap installed on metallic pipes where T Ratings are required by applicable building code requirements,
   a. Specified Technologies, Inc. (STI) SpecSeal T-Collar Device

18. Fire-Rated Cable Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing cable penetrations up to 0.53 in. (14 mm) diameter,
   a. Specified Technologies, Inc. (STI) Ready Firestop Grommet (RFG1 or RFG2)

C. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

D. Provide paintable surface material where firestopping is exposed to view, excluding maintenance areas.

E. Pillow/Brick firestopping is not allowed.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION
   A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
   B. Remove incompatible materials that could adversely affect bond.
   C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION
   A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
   B. Do not cover installed firestopping until inspected by authority having jurisdiction.
   C. Install labeling required by code.
   D. Identify penetration firestopping with preprinted vinyl metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge and at intervals not exceeding 30 feet horizontally along wall or partition so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
1. The words "WARNING - FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS WITH PENETRATION FIRESTOPPING - DO NOT DISTURB. NOTIFY BUILDING MANAGEMENT OF ANY DAMAGE," with all letters a minimum of 1/2 inch in height.
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

E. Label each rated wall assembly per applicable code requirements (including but not limited to concealed floor, floor-ceiling, or attic areas above finished ceilings).

3.04 CLEANING
A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION
A. Clean adjacent surfaces of firestopping materials.
B. Protect adjacent surfaces from damage by material installation.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Sealants and joint backing.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data indicating sealant chemical characteristics.
   C. LEED Report: Submit VOC content documentation for all non-preformed sealants and primers.
   D. Manufacturer's Installation Instructions: Indicate special procedures.
   E. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.
   F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
      1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
      2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
   G. Warranties: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE
   A. Applicator Qualifications: Company specializing in performing the work of this section with minimum 10 years experience or approved by Manufacturer.
   B. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:
      1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
      2. Conduct field tests for each application of elastomeric sealant and joint substrate indicated.
      3. Notify Architect seven days in advance of dates and times when test joints will be erected.
      4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
      6. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
      7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.05 MOCK-UP
   A. Provide mock-up of sealant joints in conjunction with window, wall, and doors under provisions of Section 01 40 00.
   B. Construct mock-up with specified sealant types and with other components noted.
   C. Locate where directed.
   D. Mock-up may remain as part of the Work.
1.06 FIELD CONDITIONS
   A. Maintain temperature and humidity recommended by the sealant manufacturer during and after
      installation.

1.07 COORDINATION
   A. Coordinate the work with all sections referencing this section.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective work within a 10 year period after Date of Substantial Completion.
   C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight
      seal, watertight seal, and non-bleeding, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 SEALANTS
   A. Provide only products having lower volatile organic compound (VOC) content than required by
      South Coast Air Quality Management District Rule No.1168.
      1. VOC Content: Provide sealants and sealant primers that comply with the following limits
         for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
         a. Architectural Sealants: 250 g/L.
         b. Roofing Sealant: 300 g/L.
         c. Single Ply Membrane Sealer: 450 g/L.
         d. Other sealants: 420 g/L.
         e. Primers for Nonporous Substrates: 250 g/L.
         f. Primers for Porous Substrates: 775 g/L.
   B. Compatibility: Provide joint sealants, backings, and other related materials that are compatible
      with one another and with joint substrates under conditions of service and application, as
      demonstrated by sealant manufacturer, based on testing and field experience.
   C. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each
      liquid-applied chemically curing sealant specified, including those referencing ASTM C 920
      classifications for type, grade, class, and uses related to exposure and joint substrates.
   D. Stain-Test-Response Characteristics: Provide products that have undergone testing according
      to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
   E. Exterior Building Joint Sealant: Dow Corning 795, for vertical joints including:
      1. Panel joints
      2. Joints between products
      3. Joints in sheet metal fabrications
   F. Exterior Building Joint Sealant, non-bleeding: Dow Corning 756 SMS.
      1. Use in contact with stone or ceramic tile to assure no bleeding.
      2. Provide non-staining warranty
   G. Exterior Pavement Joint Sealant: Sonneborn SL-2, 2-part urethane
   H. Interior Horizontal Concrete Joint Sealant: Sonneborn Epolith-P, 2-part epoxy
   I. Interior Vertical Joint Sealant: Sonneborn Sonolac, 1-part acrylic
   J. Interior Bath and Toilet Room Sealant: GE Sanitary 1700 or Dow 786, silicone
   K. Interior Acoustical Joint Sealant: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant formulated for sealing interior concealed joints to reduce
      transmission of airborne sound, complying with ASTM C919.
   L. Colors: Selected from full range except where custom color is specified.

2.02 ACCESSORIES
   A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3  EXECUTION

3.01  EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.02  PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03  INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Install bond breaker where joint backing is not used.

D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

E. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

F. Tool joints concave.

3.04  CLEANING

A. Clean adjacent soiled surfaces.

3.05  PROTECTION

A. Protect sealants until cured.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Expansion joint assemblies for floor, wall, ceiling and soffit surfaces.

1.02 RELATED REQUIREMENTS
A. Section 03 10 00 - Concrete Forming and Accessories: Placement of joint assembly frames in formwork.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices, available colors and finish.
C. Shop Drawings: Indicate joint and splice locations, miters, layout of the work, affected adjacent construction, anchorage locations.
D. Samples: Submit two samples 6 inch long, illustrating profile, dimension, color, and finish selected.
E. Manufacturer’s Installation Instructions: Indicate rough-in sizes; provide templates for cast-in or placed frames or anchors; required tolerances for item placement.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Expansion Joint Cover Assemblies:
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 EXPANSION JOINT COVER ASSEMBLY APPLICATIONS
A. Interior Floor Joints Subject to Seismic Movement at New Concrete Slab Expansion Joint Floor Pan System:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.
B. Interior Floor Joints Subject to Seismic Movement at Expansion Joint Fire Barrier:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.
C. Interior Wall/Ceiling Joints Subject to Thermal Movement - Acoustical Ceiling to Wall:
   1. Products:
EXPANSION JOINT COVER ASSEMBLIES

b. Substitutions: See Section 01 60 00 - Product Requirements.

D. Interior Ceiling/Ceiling Joints Subject to Thermal Movement - Acoustical Ceiling to Acoustical Ceiling:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

E. Interior Non-Fire-Rated Wall/Ceiling Joints Subject to Seismic Movement - Expansion Joint Glide Plate:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

F. Interior Fire-Rated Wall/Ceiling Joints Subject to Seismic Movement:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

G. Interior Wall/Ceiling Joints Subject to Thermal Movement - Gypsum Board Ceiling to Wall:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

H. Interior Wall/Wall Joints Subject to Thermal Movement - Gypsum Board Wall to Gypsum Board Wall:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

I.

J. Exterior Wall Joints Subject to Thermal Movement:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

K. Exterior Wall Joints Subject to Seismic Movement:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

L. Bridge Deck Joints:
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 EXPANSION JOINT COVER ASSEMBLIES

A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled; designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke; suitable for traffic expected.
   1. Joint Dimensions and Configurations: As indicated on drawings.
   2. Joint Cover Sizes: Selected to suit joint width and configuration, based on manufacturer's published recommendations and limitations.
   3. Lengths: Provide covers in full lengths required; avoid splicing wherever possible.

B. Floor Joint Covers: Coordinate with indicated floor coverings.
C. Covers In Fire Rated Assemblies: Provide cover assembly having fire rating equivalent to that of assembly into which it is installed.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 allow, T6 temper.
   1. Exposed Finish Outdoors: Natural anodized.
   2. Exposed Finish at Walls and Ceilings: Natural anodized.

B. Resilient Seals:
   1. For Ceilings: Any resilient material, flush, pleated, or hollow gasket.
   2. For Pedestrian Traffic Applications: EPDM rubber, Neoprene, or Santoprene; no PVC; Shore A hardness of 40 to 50 Durometer.

C. Anchors and Fasteners: As recommended by cover manufacturer.

D. Ferrous Metal Anchors: Galvanized where embedded in concrete or in contact with cementitious materials.

E. Threaded Fasteners: Aluminum.

F. Backing Paint for Aluminum Components in Contact with Cementitious Materials: Asphaltic type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joint preparation and dimensions are acceptable and in accordance with manufacturer's requirements.

3.02 PREPARATION

A. Provide anchoring devices for installation and embedding under Section 03 10 00.
   1. Provide templates and rough-in measurements.

3.03 INSTALLATION

A. Install components and accessories in accordance with manufacturer's instructions.
   B. Align work plumb and level, flush with adjacent surfaces.
   C. Rigidly anchor to substrate to prevent misalignment.

3.04 PROTECTION

A. Do not permit traffic over unprotected floor joint surfaces.
   B. Provide strippable coating to protect finish surface.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES:
   A. Restoration of existing wood, steel, and aluminum window sash and frame.
   B. Replacement of broken glass.
   C. Installation of new glazing putty where missing.
   D. Repair of operating hardware.
   E. Installation of new weatherstripping at bottom of lower sash and top of upper sash.
   F. Removal of unused hardware.
   G. Refinishing existing sash, frame and trim surfaces.
   H. Finishing of new materials and surfaces.
   I. Fill all gouges, cracks, splinters and surface defects of wood windows with wood fill and epoxy.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Submit product data on new sash hardware including shop finish and type of fasteners.
   C. Submit product data on window finishing materials, including fillers, primers undercoats and finish coats.
   D. Mock-Up: Complete repair of each window type shall be performed for approval. Approved sample may be incorporated into final work.

1.03 QUALITY ASSURANCE
   A. Work must be performed by a firm having successful experience in comparable window restoration work in the last five (5) years, and employing personnel skilled in the restoration processes and operations indicated.
   1. One skilled worker shall be present at all times during execution of the work and shall personally direct the work.
   2. In acceptance or rejection of window restoration work, no allowance will be made for lack of skill on the part of the workers.

PART 2 - PRODUCTS

2.01 COMPONENTS
   A. New Window Components:
      1. Wood:
         a. Exposed Wood: Clear vertical grain, in species to match existing windows.
         b. Concealed Wood: Sound knot, mixed grain, in species to match existing windows.
         c. Shop Treatment: Treat wood with water repellent preservatives to meet NWWDA IS-2.
         d. Moisture Content: Dry wood to a moisture content between 6 and 12 percent prior to fabrication.
      2. Seal:
         a. Hot Rolled Steel Sections: ASTM A36/A36M, galvanized to ASTM A123/A123M requirements; 3 lb/ft; with slot for fitting weather stripping integral with sash section.
         b. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating; 0.02 inch thick base metal.
      3. Aluminum:
         b. Sheet Aluminum: ASTM B209 (ASTM B209M), 5005 alloy, H12 or H14 temper.
   B. Double Hung Sash Hardware:
      1. Existing Locks: Repair to meet original condition.
      2. New Locks: Match existing locks where locks are missing or damaged beyond repair.
      3. Pulleys: Repair or replace existing damaged metal pulleys.
EXISTING WINDOW MAINTENANCE

4. Weights: Repair or replace existing damaged metal weights.
5. Chains: Solid bronze or solid brass to match existing.
   a. Solid bronze: #25 - ¼" wide for up to 80 lbs.
   b. Solid bronze: #45 - 5/16" wide for up to 160 lbs.
   c. Solid brass: 5/16" wide for up to 100 lbs.
   d. Phelps Co., Dummerston, VT, 802.257.4314.

C. Window Accessories:
   1. Muntin Bars: Match existing profile.

D. Glazing:
   2. Glass: Clear Sheet Glass GL-10 and 11 at steel and aluminum windows.

E. Window Finishes:
   1. Match finishes indicated in Section 09 90 00 - Painting.

2.02 MIXES

A. Wood Treatment Oil:
   1. One part mineral spirits and one part boiled oil.

2.03 FABRICATION

A. Fabrication of Frame, Sash, and Sill Components:
   1. Fabricate components to match profile of existing windows.
   2. Fabricate frames and sash using mortise and tenon joints for wood windows (or match existing method), and welded joints ground flush and smooth, or match existing joint construction for steel and aluminum windows.

PART 3 - EXECUTION

3.01 SASH WORK:

A. Site Verification of Conditions:
   1. Review and concur with architects window survey listing defects and restoration work required.
   2. Review scope of work with Architect prior to starting renovation of windows.

B. Preparation
   1. Number each frame and sash to indicate floor, location, and component to facilitate reinstallation.
   2. Remove broken and cracked glass.
   3. Determine the soundness of all existing glazing putty. If putty is determined to be unsound, notify owner immediately to arrange for removal.
   4. Wipe muntin and sash rabbet clean to prepare for new finish. If it is determined that scraping is required to remove bed putty and contaminating materials, notify owner immediately to arrange for removal.
   5. Remove unused window hardware from sash, frame and trim surfaces.

C. Removal of Damaged Wood:
   1. Replace rotten wood sash, frame and trim with new wood in species to match existing wood. Custom mill new sash to match existing sash profile with mortise and tenon joints. Architect is to review/approve any new wood prior to installation.
   2. Replace or patch grooved, notched, split and drilled wood sash, frame and trim.
   3. When cost effective, patch damaged wood with epoxy.

D. Installation of Glass
   1. Any glass that is missing, tinted, cracked or otherwise non-historical, shall be replaced with matching thickness glass, unless glass is being upgraded to insulated.
EXISTING WINDOW MAINTENANCE

2. When restoration work is complete, reinstall existing glass, or new glass as applicable. With new glass stop and glaze to match historical original.
3. Install new insulated glass panels with true divided lite.
4. Apply a bead of bed glazing to exposed and cleaned glazing rabbet.
5. Install original undamaged glass or new glass cover over bed glazing.
6. Install two push points on each side, top and bottom of glazed opening.
7. Install new glazing putty to smooth beveled finish.
8. Install silicone sealant to seal between glass and sash at areas where glass does not lay tight against the frame.

E. Renovation of Window Hardware:
1. Any missing pieces, pieces beyond repair such as locks, weights, cords, etc. will be replaced to match original. It is highly recommended that all replacement parts and pieces be approved prior to bid, however, the architect must approve, prior to installation, all replacement hardware and profiles. Any additional hardware needed to rebalance the window is subject to the architect’s approval. All care and expertise should be used to rebalance the system without additional non-historical hardware.
2. Replace and repair sash hardware per window survey.
3. Install bulb neoprene weatherstripping on sash stiles and rails.
4. Clean, lubricate and adjust operating window hardware until hardware operates smooth and with a little effort from building occupants.

F. Refinishing Exterior Wood Window Surfaces:
1. Wash and wipe dry window sash, frame and trim surfaces.
2. Apply paint finish to interior painted wood window assembly surfaces as indicated in Section 09 90 00.
3. Sashes are to receive (2) coats of paint approved by architect.

3.02 WINDOW FRAME FINISH

A. Window finishes should be applied in the refurbishing shop. For conditions requiring field finish see Section 09 90 00.

3.03 COMPLETION

A. Adjusting and Cleaning:
1. Check sash operation and correct units where sash does not operate smooth and with little effort from building occupants.
2. Remove protective materials from Site.
3. Wash and wipe dry glass, sash, and frames prior to substantial Completion.
4. Windows are to be cleaned prior to final payment for work performed.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated steel doors and frames.
B. Steel frames for wood doors.
C. Fire-rated steel doors and frames.
D. Thermally insulated steel doors.
E. Steel glazing frames.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
   1. Schedule: Coordinated with other doors, frames, hardware, glazing, finishes and accessories.
D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
B. Quality Standard: In addition to requirements specified, comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
C. Maintain at the project site a copy of all reference standards dealing with installation.
D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL 10C.
   1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
   2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
      a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
E. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.

F. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Store in accordance with NAAMM HMMA 840.
B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Steel Doors and Frames: Member of HMMA or SDI that produces products complying with requirements.

2.02 DOORS AND FRAMES
A. Requirements for All Doors and Frames:
   1. Door Top Closures: Flush with top of faces and edges.
   2. Door Edge Profile: Beveled on both edges.
   4. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
   5. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
   6. Galvanizing all Units: All components hot-dipped zinc-iron alloy-coated (galvannealed), A60/ZF180.
   7. Finish: Factory primed, for field finishing.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 STEEL DOORS
A. Exterior Doors:
   1. Grade: ANSI A250.8 Level 3, physical performance Level A, Model 2, seamless.
   2. Core: Polyurethane, foamed in place.
   3. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.
   4. Finish:
      a. MP-4 finish to match MP-4 exterior wall panel finish.
      b. MP-1 finish to match MP-1/IP-2 wall panel Finish.

B. Interior Doors, Non-Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
   2. Core: Polystyrene foam.
   3. Finish: Factory primed, for field finishing.

C. Interior Doors, Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
   2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C (“positive pressure”).
      a. Provide units listed and labeled by UL.
      b. Attach fire rating label to each fire rated unit.
3. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch w.g. pressure at both ambient and elevated temperatures; with "S" label; if necessary, provide additional gasketing or edge sealing.


D. Energy Efficiency Hollow Metal Doors:
   1. General: Provide 1-3/4 inch doors of design specified, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
   2. Exterior Doors: Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.
      a. Design: Flush panel.
         1) Roof Access Door Frame: 4-sided frame.
      b. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 “Laminated Core”.
         1) Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5” on- center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
         2) Thermal properties to rate at a fully operable minimum U-Factor 0.29 and R-Value 3.4, including insulated door, thermal-break frame and threshold.
            (a) Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.36 and R-Value 2.8, including insulated door, kerf type frame, and threshold.
      c. Level/Model: Level 2 and Physical Performance Level A (Heavy Duty), Minimum 18 gauge (0.042 inch - 1.1-mm) thick steel, Model 2.
      d. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam.
         Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
      e. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
      f. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
      g. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

2.04 STEEL FRAMES

A. General:
   1. Comply with the requirements of grade specified for corresponding door, except:
      a. Exterior Frames: Not less than 14 gage.
      b. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 2.
   2. Finish: Same as for door.
   3. Frame with Opening Wider than 48 inches: Increase material thickness by 2 gages.

B. Exterior Door Frames: Fully welded.
   1. Weatherstripping: Separate, see Section 08 71 00.

C. Interior Door Frames, Non-Fire-Rated: Fully welded type.

D. Interior Door Frames, Fire-Rated: Fully welded type.
   1. Fire Rating: Same as door, labeled.
E. Energy Efficiency Hollow Metal Frames:
   1. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames, provide where indicated thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate from minimum 16 gauge galvannealed steel, with positive 3/8" vinyl thermal break and integral vinyl weatherstripping. Thermal break frames available as knock down types only.
      a. Manufacturers Basis of Design:
         1) CECO Door Products - Thermal Break SQT and SRT Series.
         2) Curries Company - Thermal Break M and C Series.
         3) Substitutions: See Section 01 60 00 - Product Requirements.
   2. Weatherstripped Frames: Subject to the same compliance standards and requirements as standard hollow metal frames, provide where indicated weatherstripped profiles with 1/8" integral kerf formed into the frame soffit able to receive manufacturer's listed gasket material. Available for use in both masonry and drywall construction, with fire rating up to 3 hours complying with NFPA 105, UL 1784, and ASTM E-283 Test criteria.

F. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

G. Transom Bars: Fixed, of profile same as jamb and head.

2.05 ACCESSORY MATERIALS

A. Glazing: As specified in Section 08 80 00, factory installed.

B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

C. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
   1. Do not prepare frames for silencers where weatherstripping or gasketting is indicated.

D. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

E. Galvanizing Repair Paint: Tnemec Series 135

2.06 FINISH MATERIALS

A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard, except silicone modified resin is not acceptable.

B. Galvanizing Touch-Up Paint: Zinc rich primer compatible with finish paint system.

C. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.
   1. Automotive undercoating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

3.02 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

B. Coat inside of other frames with bituminous coating to a thickness of 1/16 inch.

3.03 INSTALLATION

A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.

B. In addition, install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.
D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
   1. Coat interior of frame with undercoating.

E. Coordinate installation of hardware.
F. Coordinate installation of glazing.
G. Coordinate installation of electrical connections to electrical hardware items.
H. Touch up damaged factory finishes.

3.04 ADJUSTING
A. Adjust for smooth and balanced door movement.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Flush solid wood doors

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
C. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria, identify cutouts for glazing and louvers.
D. Samples: Submit two samples of door construction, 12 by 18 inch in size cut from top corner of door.
E. Samples: Submit two samples of door veneer, 12 by 12 inch in size illustrating wood grain, stain color, and sheen.
F. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   4. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   5. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
   6. Credit EQ 4.4: Composite wood manufacturer's product data for each composite wood product used indicating that bonding agent used contains no urea formaldehyde.

1.03 QUALITY ASSURANCE
B. Installed Fire Rated Door and Transom Panel Assembly: Conform to NFPA 80 for fire rated class as indicated.
C. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, comply with air leakage requirements of UBC Std 7-2, Part II; with "S" label; if necessary, provide additional gasketing or edge sealing.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Package, deliver and store doors in accordance with specified quality standard.
B. Accept doors on site in manufacturer's packaging. Inspect for damage.
C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.05 PROJECT CONDITIONS
A. Coordinate the work with door opening construction, door frame and door hardware installation.

1.06 WARRANTY
A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
FLUSH WOOD DOORS

B. Provide warranty for the following term:
   1. Interior Doors: Life of installation.

C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Solid Wood Doors:
   1. Provide products that comply with requirements from a company specializing in manufacturing the products specified in this section and that is a member of WI, AWI, or WDMA.
      a. AWS Quality Standard: Premium Grade.
         1)  
         2)  
         3)  
         4)  
      b. Match paneling, see Section 06 42 16.
      c. Matching custom solid wood door frames, see Section 06 20 00

B. Provide products that comply with requirements from one of the following:
   1. Lynden Door, Inc.
   2. Oregon Door
   3. Portland Millwork
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOORS AND PANELS

A. All Doors: See drawings for locations and additional requirements.
   1. Quality Level: Premium grade solid wood doors and frames matching paneling in Section 06 42 16, in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 4.

B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
   1. Provide core doors at all locations indicated.
   2. Doors must comply with Window and Door Manufacturer's Association (WDMA)Specifications IS 1A-97; General Requirements for Flush Wood Doors.
   3. Wood veneer facing with factory transparent finish.
   4. Doors and door components (including cores, faces, etc.) to be fabricated with no added urea formaldehyde (NAUF).
   5. 100% recycled fiber particleboard core.
   6. Mineral core where indicated on opening schedule, to rating indicated.

C. Legend:
   1. WD-1: Wood veneer to match WCW-1 on adjacent walls
   2. WD-2: Not used.
   3. WD-3: Door clads in wood paneling to match WCW-1 on adjacent walls
   4. WD-4: Oak Door veneer to match adjacent oak walls
   5. MDF veneer facing for field opaque finish (AWS Custom Grade).

2.03 ACCESSORIES

A. Glazing Stops: Wood, of same species as door facing, mitered corners; prepared for countersink style tamper proof screws.

B. Adhesive: Type I

C. Intumescent Seals: Semi-concealed in door edge, comply with UL 10C

2.04 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.
B. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

C. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.

D. Provide edge clearances in accordance with the quality standard specified.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standard.

B. Use machine tools to cut or drill for hardware.

C. Coordinate installation of doors with installation of frames and hardware.

D. Coordinate installation of glazing.

3.03 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

B. Adjust closers for full closure.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Ceiling access door and frame units.
   B. Access door and frame units, fire-rated, in wall and ceiling locations.

1.02 REFERENCE STANDARDS

1.03 DESIGN REQUIREMENTS
   A. Fabricate floor access assemblies to support live load of 100 lb/sq ft with deflection not to exceed 1/180 of span.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
   C. Shop Drawings: Schedule of sizes and locations. Indicate exact position of all access door units.
   D. Manufacturer's Installation Instructions: Indicate installation requirements.
   E. Project Record Documents: Record actual locations of all access units.

1.05 REGULATORY REQUIREMENTS
   A. Conform to applicable code for fire rated access doors.
      1. Provide access doors of fire rating equivalent to the fire rated assembly in which they are to be installed.
   B. Provide products listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.

1.06 PROJECT CONDITIONS
   A. Coordinate the work with other work requiring access doors.

PART 2 PRODUCTS

2.01 ACCESS DOOR AND PANEL APPLICATIONS
   A. Walls, Unless Otherwise Indicated:
      1. Size: 24 x 30 inches, unless otherwise indicated.
   B. Fire and Smoke Rated Shaft Walls: See drawings for shaft wall fire and smoke ratings.
      1. Material: Steel.
         a. Frame: 16 gauge cold rolled steel with 1 inch flanges
         b. Door: 20 gauge double skin insulated sandwich panel.
         c. Hinge: Flush continuous piano hinge.
         d. Latch: Cylinder keyed self latching with interior latch release mechanism.
         e. Closer: Self-closing automatic closer.
         f. Gasketing: All 4 sides.
      2. Minimum Size: 24 inches by 30 inches, for personnel access and 16 x 16 inches for valve access, unless otherwise indicated.
         a. Access Door Size: Sufficient to allow For all system components requiring maintenance panel size must be sufficient to repair the equipment.
         b. Label access to shut-offs. Label should read, "EMERGENCY _______ SHUT-OFF"
         c.
2.02 MANUFACTURERS

2.03 WALL AND CEILING UNITS

A. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.

1. Door Style: Single thickness with rolled or turned in edges.

2.04 ACCESS DOOR UNITS - WALLS

2.05 FABRICATION

A. Weld, fill, and grind joints to ensure flush and square unit.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings. Secure rigidly in place.

C. Position units to provide convenient access to the concealed work requiring access.

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
A. Overhead coiling metal grilles and operating hardware, manual and electric operation.
B. Wiring from electric circuit disconnect to operator to control station.

1.02  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general construction, component connections and details, electrical equipment.
C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
D. Samples: Submit two grille members, 12 x 12 inch in size illustrating shape, color and finish texture.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   1. Credit MR 4: Recycled content for each product, post-consumer and post-industrial.
      Product cost data.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture.
      Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
F. Manufacturer's Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
G. Maintenance Data: Indicate lubrication requirements and frequency.

1.03  REGULATORY REQUIREMENTS
A. Provide certificate of compliance from authority having jurisdiction indicating approval of grille and operating hardware assembly.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.04  WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a two year period after Date of Substantial Completion.
C. Provide one year service and maintenance agreement for installed system for one year owner's consideration from Date of Substantial Completion.
   1. Examine system components monthly. Clean, adjust, and lubricate equipment.
   2. Include systematic examination, adjustment, and lubrication of elevator equipment.
      Maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.

PART 2  PRODUCTS
2.01  MANUFACTURERS
B. Acceptable manufacturers pending conformance to Design Basis requirements:
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GRILLE AND COMPONENTS
A. Grille: Aluminum; horizontal bar curtain, coiling on overhead counterbalanced shaft.
   1. Finish: No. 4.
   3. Electric operation at public space locations.
B. Curtain: Custom ACL pattern at ASUO, Market and Coffee vendor frontages.
C. Guides: Extruded aluminum angles, of profile to retain grille in place with snap-on trim, mounting brackets of same metal.
D. Hood Enclosure: Sheet metal; completely covering operating mechanisms; internally reinforced to maintain rigidity and shape.
   1. Material: Same metal as grille.
   2. Sheet Metal Thickness: 22 gage.
E. Hardware:
   1. Lock Cylinders: Specified in Section 08 71 00.
   2. Latching: Inside mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position.
   3. Latch Handle: Interior and exterior handle.
F. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.03 MATERIALS
A. Aluminum: ASTM B221 (ASTM B221M).
B. Stainless Steel: ASTM A 666, Type 304,rollable temper.

2.04 ELECTRIC OPERATION
A. Electric Operators:
   1. Mounting: Side mounted.
   2. Motor Enclosure:
      a. Exterior grilles: NEMA MG 1 Type 4; open drip proof.
      b. Interior grilles: NEMA MG 1 Type 1; open drip proof.
   5. Controller Enclosure: NEMA 250 Type 1.
   6. Opening Speed: 12 inches per second.
B. Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.
   1. 24 volt circuit.
   2. Surface mounted.
C. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that opening sizes, tolerances and conditions are acceptable.
3.02 INSTALLATION
   A. Install grille unit assembly in accordance with manufacturer's instructions.
   B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
   C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
   D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
   E. Coordinate installation of electrical service with Section 26 27 17.
   F. Complete wiring from disconnect to unit components.
   G. Install perimeter trim.

3.03 TOLERANCES
   A. Maintain dimensional tolerances and alignment with adjacent work.
   B. Maximum Variation From Plumb: 1/16 inch.
   C. Maximum Variation From Level: 1/16 inch.
   D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING
   A. Adjust grille, hardware and operating assemblies for smooth and noiseless operation.

3.05 CLEANING
   A. Clean grille and components.
   B. Remove labels and visible markings.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Side coiling metal grilles and operating hardware, manual operation.

1.02 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general construction, component connections and details, electrical equipment.
C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
D. Samples: Submit two grille members, 12 x 12 inch in size illustrating shape, color and finish texture.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers’ product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
F. Manufacturer’s Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
G. Maintenance Data: Indicate lubrication requirements and frequency.

1.03 REGULATORY REQUIREMENTS

A. Provide certificate of compliance from authority having jurisdiction indicating approval of grille and operating hardware assembly.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.04 QUALITY ASSURANCE

A. Manufacturer Requirements: Side coiling door manufacturer shall have been in the business of and have experience in manufacturing the type of product covered under this specification section as well as giving credible service for a minimum of five (5) years. Provide list of at least ten (10) completed projects which include the products covered under this section.

1.05 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials in manufacturer’s original packaging, labeled to show name, brand and type. Store materials in a protected dry location off the ground in accordance with manufacturer’s instructions.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a two year period after Date of Substantial Completion.
C. Provide one year service and maintenance agreement for installed system for owner’s consideration:
   1. Include monthly systematic examination, adjustment, and lubrication of equipment. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment.
D. Side Coiling Door Warranty: Furnish two year written warranty signed by the manufacturer and installer agreeing to repair or replace work which has failed as a result of defects in materials or workmanship. Upon notification within the warranty period, such defects shall be repaired at no cost to the owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS


B. Acceptable manufacturers pending conformance to Design Basis requirements:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GRILLE AND COMPONENTS

A. Grille: Interlocking slat curtain for horizontal plane travel driven to open and close position manually by a positive action sprocket drive, without the use of cables or counterbalance weights. Custom ACL pattern at ASUO, Market and Coffee vendor frontages.
   1. Curtain: Shall be fabricated of aluminum slats with an approximate cross section not less than 3" wide by 7/8" deep.

B. Leading Edge: Curtain shall be furnished with an extruded aluminum member of tubular design to provide stiffness, limit deflection and provide for a tight fitting closure.

C. Receiving Edge: Shall be fabricated of an extruded aluminum member with sufficient depth, designed to accept the leading edge and form a tight fitting closure when the door is in the fully closed position.

D. Head Track: Shall be of not less than 1/8" thick steel and shall be provided with an integral locking bar. The faying surface shall not be less than 38% of the flat plate area when the side coiling door is in the closed position. Locking bar shall lock and retain the coiling curtain in place.

E. Floor Track (Optional): Shall be no greater than 1 1/2" deep and include integral removable stainless steel protective cover plates to allow for easy cleaning and proper maintenance.

F. Counterbalance Assemblies: The side coiling door shall be counterbalanced by means of adjustable steel helical torsion springs attached to shaft enclosed in pipe with required mounting blocks for attachment of curtain. Torsion springs shall be anchored to the same shaft and held in position by the same adjusting wheel accessible from outside the barrel assemblies.

G. Coil Box: Shall be provided to entirely enclose coiled curtain and counterbalance assemblies. Coil box cover shall be of a rectangular design fabricated of 22 gauge galvanized sheet steel.

PART 3 EXECUTION

3.01 3.01 EXAMINATION

A. Examine surfaces and field conditions to which this work is to be performed and notify architect if conditions of surfaces exist which are detrimental to proper installation and timely completion of work.

B. Verify all dimensions taken at job site affecting the work. Notify the architect in any instance where dimensions vary.

C. Coordinate and schedule work under this section with work of other sections so as not to delay job progress.

3.02 3.02 INSTALLATION

A. Perform installation using only factory approved and certified representatives of the side coiling door manufacturer.
B. Install side coiling door assemblies at locations shown in perfect alignment and elevation, plumb, level, straight and true.
C. Adjust side coiling door installation to provide uniform clearances and smooth non-binding operation.
D. Install wiring in accordance with applicable local codes and the National Electrical Code Standard. Materials shall be UL listed.

3.03 3.03 PROTECTION AND CLEANING
A. Protect installed work using adequate and suitable means during and after installation until accepted by owner.
B. Remove, repair or replace materials which have been damaged in any way.
C. Clean surfaces of grime and dirt using acceptable and recommended means and methods.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A.  All-glass entrances.
   B.  Swinging doors.

1.02  REFERENCE STANDARDS

1.03  SUBMITTALS
   A.  See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B.  Product Data: Manufacturer's descriptive literature for each component in all-glass entrance assembly.
   C.  Shop Drawings: Drawings showing layout, dimensions, identification of components, and interface with adjacent construction.
      1.  Include field measurements of openings.
      2.  Include elevations showing:
            a.  Appearance of all-glass entrance layouts.
            b.  Locations and identification of manufacturer-supplied door hardware and fittings.
            c.  Locations and sizes of cut-outs and drilled holes for other door hardware.
      3.  Include details of:
            a.  Requirements for support and bracing at openings.
            b.  Installation details.
            c.  Appearance of manufacturer-supplied door hardware and fittings.
      4.  Schedule: Listing of each type component in all-glass entrance assemblies, cross-referenced to shop drawing plans, elevations, and details.
   D.  LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2.  Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      3.  Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   E.  Design Data: Design calculations, bearing seal and signature of structural engineer licensed to practice in the State in which the Project is located, documenting compliance of exterior assemblies with wind pressure criteria.
   F.  Certificates: Contractor's certification that installer of entrance assemblies meets specified qualifications.
1.04 QUALITY ASSURANCE

A. Designer Qualifications: Design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Installer Qualifications: Minimum three years of experience installing entrance assemblies similar to those specified in this section.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. All-Glass Entrances and Storefronts:
      a. Product: ThermlBlock.
   2. Acceptable manufacturers pending conformance to Design Basis requirements:
      a. Product: D302
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Fittings and Hardware: By storefront manufacturer.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ASSEMBLIES

A. Entrances and Storefronts: Factory fabricated assemblies consisting of frameless glass panels fastened with metal structural fittings in configuration indicated on the drawings.
   1. Operational Loads: Designed to withstand door operation under normal traffic without damage, racking, sagging, or deflection.
   2. Prepared for all specified hardware whether specified in this section or not.
   3. Finished metal surfaces protected with strippable film.
   4. Factory assembled to greatest extent practicable; may be disassembled to accommodate shipping constraints.

2.03 FITTINGS

A. Swinging Door Fittings:
   1. Rail Cross-Section: 1-3/4 inches wide by 3-1/2 inches high.
   2. Rail Profile: Tapered.

2.04 MATERIALS

A. Glass: Tempered float glass meeting requirements of ASTM C1036, Type I, Quality Q3, fully tempered in accordance with ASTM C1048, Kind FT, and as follows:
   1. Thickness: 3/4 inch.
   3. Prepare glazing panels for indicated fittings and hardware before tempering.
   4. Polish edges that will be exposed in finished work to bright flat polish.
   5. Temper glass materials horizontally; visible tong marks or tong mark distortions are not permitted.

B. Aluminum Components: Conforming to ASTM B221 (ASTM B221M), Alloy 6063, Temper T5.

C. Sealant: One-part silicone sealant, conforming to ASTM C920, clear.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings are acceptable.

B. Do not begin installation until substrates and openings have been properly prepared.
C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean substrates thoroughly prior to installation.
B. Prepare substrates using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Tolerances:
   1. Horizontal Components and Sight Lines: Not more than 1/8 inch in 10 feet variation from level, non-cumulative.
   2. Vertical Components and Sight Lines: Not more than 1/8 inch in 10 feet variation from plumb, non-cumulative.
   3. Variation from Plane or Indicated Location: Not more than 1/16 inch.

3.04 ADJUSTING

A. Adjust doors to operate correctly, without binding to frame, sill, or adjacent doors.
B. Adjust door hardware for smooth operation.

3.05 CLEANING

A. Clean installed work to like-new condition.

3.06 PROTECTION

A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Aluminum-framed curtain wall, with vision glazing and glass, metal, and stone infill panels.
B. Perimeter sealant.
C. Firestopping between curtain wall and edge of floor slab.

1.02 REFERENCE STANDARDS
A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2012.

1.03 PERFORMANCE REQUIREMENTS
A. Design and size components to withstand the following load requirements without damage or permanent set:
   1. Positive Design Wind Load: 30 lbf/sq ft.
   2. Negative Design Wind Load: 30 lbf/sq ft.
   3. Member Deflection: Limit member deflection to 1/175 inch in any direction, and maximum of 3/4 inch, with full recovery of glazing materials.
   4. Measure performance by testing in accordance with ASTM E 330, using test loads equal to 1.5 times the design wind loads and 10 second duration of maximum pressure.
B. Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with building code.
C. Movement: Accommodate the following movement without damage to components or deterioration of seals:
   1. Movement of curtain wall relative to perimeter framing.
   2. Deflection of structural support framing, under permanent and dynamic loads.
   4. Creep of structural concrete members.
   5. Mid-span slab edge deflection of 0.75 inch.
D. When tested in accordance with ASTM E 283 and TAS 202, completed
E. Air Infiltration: Limit air infiltration through assembly to 0.06 cu ft/min/sq ft of wall area, measured at a reference differential pressure across assembly of 6.24 psf as measured in accordance with ASTM E 283.
ALUMINUM FRAMED CURTAIN WALL

1. Limit air infiltration through operable vents assembly to 0.10 CFM/FT² (1.83 m³/h·m²) when tested at differential static pressure of 6.24 PSF (299 Pa) in accordance with ASTM E 283.

F. Condensation Resistance Factor: CRF of 55 when measured in accordance with AAMA 1503.1.
1. CRF of 45 at operable vents.

G. Water Leakage: None, when measured in accordance with ASTM E 331 at a test pressure difference of 15 lbf/sq ft.
1. None, when measured in accordance with ASTM E1105 Field Testing to 10 lbs/sq ft.

H. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

I. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.

J. Overall System U-Value: Not to exceed 0.35.

K. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.

L. Design system to eliminate noises caused by wind and thermal movement, to prevent vibration harmonics, and to prevent "stack effect" in internal spaces.

M. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

N. Operable Vents to comply with AAMA 513-12 for opening forces and motions required to activate operable parts of curtain wall systems. Where operable vents are not tested to and do not comply with this standard, provide integral motorized operators for a minimum of one operable vent in each room containing operable vents.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glazing and infill, internal drainage details and operable hardware.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

D. Samples: Submit two samples 3 by 5 inches in size illustrating finished aluminum surface, glazing, infill panels, glazing materials.

E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers’ product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
F. Test Reports: Submit results of full-size mock-up testing. Reports of tests previously performed on the same design are acceptable.

G. Schedules: Provide component, accessory and fastener schedules, relating to system, including sealant, tapes, gaskets, anchors, etc. Provide glazing installation instructions and reglazing procedures.

H. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.
   1. Comply with Section 01 33 16 - Delegated Design Procedures.

I. Manufacturer’s Certificate: Certify that the products supplied meet or exceed the specified requirements.

J. Report of field testing for water leakage.

K. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the State in which the Project is located.

B. Manufacturer and Installer: Company specializing in manufacturing aluminum glazing systems with minimum 10 years of documented experience.

C. Single Source Responsibility.

D. Testing Agency Qualifications: AAMA - Accredited Laboratory for field tests as indicated.

E. ASTM E1105 (Standard Test Method for Field Determination of Water Penetration of Installed Windows, Skylights, Doors, by Uniform or Cyclic Static Air Pressure Differences).

F. Product Options: Information on Drawings and in Specifications establishes requirements for systems’ 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.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

G. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.06 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.
1.08 PROJECT CONDITIONS
   A. Coordinate the work with installation of firestopping components or materials.

1.09 FIELD CONDITIONS
   A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.10 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Structural failures including, but not limited to, excessive deflection.
         b. Noise or vibration caused by thermal movements.
         c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
         d. Adhesive or cohesive sealant failures.
         e. Water leakage through fixed glazing and framing areas.
         f. Failure of operating components.
      2. Warranty Period: Ten (10) years from date of Substantial Completion.
   C. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
      1. Warranty Period: Twenty (20) years from date of Substantial Completion.
      2. Contractor Warranty: Correct defective Work within a two (2) year period after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Design Basis: Subject to compliance with requirements, provide curtain wall products by Wausau Window and Wall Systems Superwall and Superwall SSG; www.wausauwindow.com. Manufacturers providing comparable products that may be incorporated into the work include, any manufacturer in accordance with 1.02 Performance Requirements, aesthetic design intent, and installation requirements in 3.02 of this Section.

2.02 CURTAIN WALL
   A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
      1. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
      3. Air and Vapor Seal: Maintain continuous air barrier and vapor retarder throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound. At transitions to adjacent assemblies provision for for adhering and mechanical clamping of self adhered membrane into shoulder of curtain wall system, as indicated on drawings.

2.03 DOORS
   A. Doors: See Section 08 41 26 - All Glass Entrances and Storefronts.
2.04 COMPONENTS

A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.

B. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
   1. Mullions: Design intent for Delegated Design to provide sizes, 6, 8, and 10 inch nominal mullions as indicated on drawings, to achieve required clearances from set structural members.

C. System Description: Concealed frame (structurally glazed), with zero sightline operable awning windows integrated within curtain wall system by manufacturer captured framed curtain wall system.

D. Operable Vents:
   1. Zero sightline profile, as indicated in drawings
   2. Hardware
      a. 6-inch limiters
      b. ADA compliant opening and closing pressures.
      c. Electronic contact tied to HVAC controls
   3. Accessories:
      a. Insect Screens to fit operable unit, installed and serviced from interior

E. Glazing: As specified in Section 08 80 00.

2.05 MATERIALS


B. Firestopping: As specified in Section 07 84 00.

C. Perimeter Sealant: Type exterior building sealant specified in Section 07 90 05.

D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

E. Glazing Accessories: As specified in Section 08 80 00.

2.06 FINISHES

A. High Performance Organic Finish: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

2.07 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

E. Arrange fasteners and attachments to conceal from view.

F. Reinforce framing members for imposed loads.

G. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.

H. Provide weeps/drainage of framing components and glazing cavities.

I. Seal joints to provide continuity of air and water barriers.

J. Protect or separate dissimilar metals to prevent damaging effects.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.
B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

C. Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Coordinate attachment and seal of perimeter air and vapor barrier materials.

H. Install firestopping at each floor slab edge.

I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

J. Install perimeter sealant in accordance with Section 07 90 05.

K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 FIELD QUALITY CONTROL

A. Provide the services of the manufacturer's field representative to observe installation and make report.

B. See Section 01 40 00 - Quality Requirements, for independent testing and inspection requirements. Inspection will monitor quality of installation and glazing.

C. Test installed curtain wall for water penetration in accordance with ASTM E1105

D. In-Place Testing Installation: Demonstrating all common aspects applicable to Project. Include flashing and accessory products, Coordinated with flexible flashing and sill pans, initial units for in-place mock-ups. Coordinate Work in advance with all trades.

E. Test one curtain wall of each type, as directed by Architect.

F. If any curtain wall fails, test additional curtain walls at Contractor's expense.

G. Repair or remove Work that does not meet specified requirements, or that is damaged by testing.
   1. Where repair does not produce system(s) that meet specified performance requirements, replace system(s) components with new components and re-test.
   2. Obtain Architect's acceptance of corrective Work prior to executing it.

H. Cost of corrective Work and re-testing necessary to arrive at performance requirements are Contractor's responsibility.
   1. Re-testing includes testing fees, Architect's fees, and Consultant's fees.
      a. Re-testing costs due to re-design by Architect will be paid by Owner.
3.05 MANUFACTURER’S FIELD SERVICES
   A. See Section 01 40 00 - Quality Requirements, for general requirements for manufacturerobservation of installation.
   B. Provide curtain wall manufacturer’s field surveillance of the installation. Monitor and reportinstallation procedures, unacceptable conditions and provide copies to the architect andenvelope consultant.

3.06 ADJUSTING
   A. Adjust operating sash for smooth operation.

3.07 CLEANING
   A. Remove protective material from pre-finished aluminum surfaces.
   B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, cleanwiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

3.08 INFILL PANEL SCHEDULE
   A. Infill Panel (IP):
      1. IP-1 ALUMINUM COMPOSITE MATERIAL PANEL
         a. Aluminum Composite Material (ACM) panel, Smooth Natural Aluminum Finish, Basis of Design: 4mm Alucobond natural Brushed 50
      2. IP-2 TEXTURED METAL PANEL
         a. 1” Composite Panel, with textured stainless steel front skin (Rimex Cambridge pattern), composite honeycomb and back panel. Basis of Design: Skyline SkyCore
      3. IP-3 RECLAIMED WOOD PANEL (REF 06 40 00)
         a. 1-inch Solid reclaimed douglas fir, hemlock, spruce or similar panel

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Aluminum skylight framing system.
B. Skylight glazing.
C. Fasteners, anchors, reinforcement, and flashings.

1.02 REFERENCE STANDARDS
A. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; American Architectural Manufacturers Association; 2009.

1.03 PERFORMANCE REQUIREMENTS
A. Maximum allowable deflection of any glazing support member: 1/180 of span.
B. Design system to limit stress on structural glazing adhesive to 20 percent of tested tensile adhesion and maximum compression or elongation to 25 percent of neutral dimension.
C. Design system to accommodate thermal expansion and contraction over ambient temperature range of 100 degrees F, dynamic loading and release of loads, creep of concrete structural members, and deflection of structural support framing without damage to skylight system components or loss of weathertightness.
D. Limit air infiltration through assembly to 0.06 cu ft/min/sq ft for glazed area, measured at a reference differential pressure across assembly of 6.24 psf in accordance with ASTM E 283.
E. Water Leakage: None, when measured in accordance with ASTM E 331 at a test pressure difference of 10 lbf/sq ft.
F. Design and fabricate skylight system to prevent harmonic vibration, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system.
G. Design and size components to withstand the following load requirements without damage or permanent set:
   1. Roof snow load: 27.0 lb/ft². Reference structural drawings for additional snow drift loading.
   2. Positive wind load: 12.0 lb/ft².
   3. Negative wind load: 37.0 lb/ft².
   4. Concentrated load at any location on framing: 250 lb.
   5. Measure performance by testing in accordance with ASTM E330, using test pressure equal to 1.5 times the design wind load and 10 second duration of maximum load.

H. System U Value, 0.50 maximum

I. System required to meeting fall restraint requirements of OSHA 1910.23 without the use of fall guard systems, including screens or railings.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer’s specifications, standard details, and installation requirements.
C. Shop Drawings: Indicate framed opening requirements and tolerances, spacing of all members, anticipated deflection under load, affected related work, expansion and contraction joint locations and details, and sizes and locations for field welding.
D. Samples: Submit two samples, not less than 12 x 12 inch in size illustrating appearance of prefinished aluminum and specified glazing system, including glazed edge and corner.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
F. Test Reports: Submit results of full-size mock-up testing.
G. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations.
H. Structural Glazing Adhesive: Submit product data and calculations showing compliance with performance requirements.
I. Manufacturer’s Certificate: Certify that the products supplied meet or exceed the specified requirements.
J. Report of field testing for water leakage.

1.05 QUALITY ASSURANCE
A. Design skylight system under direct supervision of a professional structural engineer experienced in design of work of the type specified in this section and licensed in the State in which the Project is located.

1.06 MOCK-UP
A. Construct mock-up that includes examples of all materials and conditions required in finished skylight installation. Size mock-up as indicated on drawings.
B. Locate where directed.
C. Mock-up may remain as part of the Work.
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Provide wrapping to protect prefinished aluminum surfaces. Do not use adhesive papers or spray coatings that bond when exposed to sunlight or weather.

1.08 PROJECT CONDITIONS
   A. Coordinate the work with the installation of roofing system and structural curb.

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective work, including leaks, discoloration, and excessive thermal or structural movement, within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   B. Acceptable manufacturers pending conformance to Design Basis requirements and to compliance with requirements herein:
      3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 METAL-FRAMED SKYLIGHTS
   A. Metal Framed Skylights: Factory-fabricated, glazed.
      1. Frame: Extruded aluminum structural members with integral condensation collection and guttering system thermally separated from exterior pressure bar.
      2. Glazing System: Pressure glazing bar system for sloped joints and structural adhesive glazing for horizontal joints.

2.03 SKYLIGHT COMPONENTS
   A. Frame: Extruded aluminum structural members with integral condensation collection and guttering system thermally separated from exterior pressure bar.
   B. Glazing System: Pressure glazing bar system for sloped joints and structural adhesive glazing for horizontal joints.
   C. Glazing: Insulating glass.

2.04 MATERIALS
   A. Aluminum Extrusions: 6063-T5, 6063-T6, or 6061-T6 members complying with ASTM B221 (ASTM B221M). Minimum thickness 0.125 inch for structural members and 0.062 inch for non-structural members.
   B. Formed Aluminum: Sheet material of alloy 5052, 5005, or 6061-T651 complying with ASTM B209 (ASTM B209M). Minimum thickness: 0.125 inch for structural members and 0.062 inches for non-structural members.
   C. Internal Reinforcement: ASTM A 36/A 36M; Steel shapes as required for strength and mullion size limitations, hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
   D. Glass: Type Skylight IGU specified in Section 08 80 00.
   E. Perimeter Sealant: Type exterior building joint as specified in Section 07 90 05.
   F. Structural Glazing Adhesive: Silicone, ASTM C920, Class 25, Grade NS, neutral cure; maximum hardness of 40, when tested in accordance with ASTM D2240 using Type A durometer; minimum tensile strength of 250 psi, when tested in accordance with ASTM D412.
   G. Weatherseal Sealant: Silicone, same type as glazing adhesive.
   H. Touch-Up Primer for Galvanized Steel Surfaces: Zinc rich type.
   I. Protective Back Coating: Asphaltic mastic, ASTM D 4479 Type I.
J. Protective Back Coating: Zinc molybdate alkyd.

2.05 FABRICATION
A. Rigidly fit and secure joints and corners with screw and spline. Make joints rigid, with connections that are flush, hairline, and weatherproof.
B. Fabricate components to allow for expansion and contraction with minimum clearance and shim spacing around perimeter of assembly.
C. Drain to exterior any water entering exterior joints, condensation occurring in glazing channels, or migrating moisture occurring within system.
D. Prepare components to receive concealed anchorage devices. Ensure that fasteners and anchorage devices will be concealed upon completion of installation.
E. Adhere glass to glazing frames with structural adhesive and cure under controlled conditions in shop. Field glazing of frames to glass is not acceptable.

2.06 FINISHES
A. High Performance Organic Finish: AAMA 2604; multiple coats, thermally cured fluoropolymer system; color as scheduled; interior surfaces only.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that structural curb is ready to receive skylight system. Coordinate installation of roofing and other adjacent work to ensure weathertight construction.

3.02 PREPARATION
A. Apply 1 coat of protective coating to concealed aluminum and steel surfaces in contact with dissimilar materials.

3.03 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Set skylight structure plumb, level, and true to line, without warp or rack of frames or glazing panels. Anchor securely in place in accordance with approved shop drawings.
C. Maintain assembly dimensional tolerances, aligning with adjacent work.
D. Install sill flashings.
E. Mask adjacent surfaces, clean joint surfaces, and install backing and field-applied sealants in accordance with requirements of Section 07 90 05.
F. Touch up damaged finishes so repair is imperceptible from 6 feet. Remove and replace components that cannot be satisfactorily touched up.

3.04 TOLERANCES
A. Maximum Variation from Plumb, Level, or Line: 1/8 inch per 10 feet, or 3/8 inch total in overall dimension.
B. Alignment of Two Adjoining Members Abutting in Plane: Within 1/16 inches.

3.05 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and inspection.
B. Test installed skylight for water leakage in accordance with AAMA 501.2.

3.06 CLEANING
A. Remove protective material from prefinished aluminum surfaces.
B. Wash down exposed surfaces; wipe surfaces clean.
C. Remove excess sealant by methods recommended by skylight manufacturer.
D. Touch up damaged finishes so repair is imperceptible from 6 feet. Remove and replace components that cannot be satisfactorily touched up.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Door hardware. Owner furnished, contractor installed.

B. Related Sections:
   1. Section 08 11 00 - Metal Doors and Frames.
   2. Section 08 14 16 – Flush Wood Doors.
   3. Section 08 43 13 – Aluminum Framed Storefronts
   4. Division 26 – Electrical

C. Specific Omissions: Hardware for the following is specified or indicated elsewhere.
   1. Windows.
   2. Cabinets, including open wall shelving and locks.
   3. Signs
   4. Toilet accessories, including grab bars.

1.02 REFERENCES:

A. American National Standards Institute – ANSI 156.18 or BHMA A156.18– Materials and Finishes.
B. ANSI A117.1 – Specifications for making buildings and facilities usable by physically handicapped people.
C. BHMA A156.18 - Materials and Finishes; current edition.
F. ADA – Americans with Disabilities Act of 1990
G. BHMA – Builders Hardware Manufacturers Association
H. DHI – Door and Hardware Institute
I. NFPA – National Fire Protection Association
J. UL – Underwriters Laboratories
K. WHI – Warnock Hersey Incorporated
L. WDI – Wood Door Institute

1.03 SUBMITTALS & SUBSTITUTIONS

A. Hardware Schedule: Submit for approval six copies of schedule per Division 1. Organize vertically formatted schedule into “Hardware Sets” with index of doors and headings, indicating complete designations of every item required for each door or opening. Include following information:
   1. Type, style, function, size, quantity and finish of hardware items.
      a. Use BHMA Finish codes per ANSI A156.18.
   2. Name, part number and manufacturer of each item.
   3. Fastenings and other pertinent information.
   4. Location of hardware set coordinated with floor plans and door schedule.
   5. Explanation of abbreviations, symbols, and codes contained in schedule.
   6. Mounting locations for hardware.
   7. Door and frame sizes, materials, hand, rating, degrees of swing, and jamb depth.
   8. List of manufacturers used and their nearest representative with address and phone number.
   9. Catalog cuts.
   10. Manufacturer’s technical data and installation instructions for electronic hardware.
   11. Date of jobsite visit if existing conditions.
12. Provide point to point wiring and riser diagrams for each electric hardware application. Include electrical items provided by others where specified. Include a system description.

B. Schedules in coded or horizontal format are unacceptable. Submittals not conforming to the above requirements will be returned without review, for re-submittal.

C. Bid and submit manufacturer's updated/improved item if scheduled item is discontinued.

D. See section 01 33 00- Submittal Procedures, for submittal procedures.

E. Make substitution requests in accordance with Division 1. Include product data and indicate benefit to the Project. Furnish operating samples on request.
   1. Items listed with no substitute manufacturers have been requested by Owner to meet existing standard.

F. Cylinders: Provide interchangeable core cylinders with factory installed keyed construction cores (Schlage ICC).
   1. Cylinder cores: Primus cores provided by Owner.
   2. Provide 10 construction keys and one control key.
   3. Permanent Keys and keying: Provided by Owner.
   4. Return temporary construction cores to hardware supplier after permanent cores are installed.

G. Closeout Submittals: Furnish 2 copies of the as-built/as-installed hardware schedule with closeout documents including wiring diagrams, manufacturers installation instructions, and suppliers final inspection report.

1.04 REFERENCES
   A. BHMA A156.18 - Materials and Finishes; current edition.

1.05 QUALITY ASSURANCE:
   A. Supplier Qualifications:
      1. Owner furnished.
   B. Hardware: New, free of defects, blemishes and excessive play. Obtain each kind of hardware (latch and locksets, exit devices, hinges and closers) from one manufacturer.
   C. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.
   D. Notify Architect of any code conflicts before ordering material.
   E. Fire-Rated Openings: In compliance with NFPA 80. Hardware UL10C/UBC-7-2 (positive pressure) compliant for given type/size opening and degree of label. Provide proper latching hardware, non-flaming door closers, approved-bearing hinges, plus resilient and required intumescent seals. Furnish openings complete.
      1. Note: scheduled seals may exceed selected door manufacturer's requirements. See 2.6.E for clarification.
   F. Pre-Installation Meetings: Initiate and conduct with supplier, installer, and related trades through Architect. Coordinate materials and techniques, and sequence complex mechanical and electrical hardware items and systems installation. Convene at least two weeks prior to commencement of related work.
      1. Confirm that Supplier has supplied necessary riser and point to point wiring diagrams for complex electric hardware systems.

1.06 DELIVERY, STORAGE AND HANDLING:
   A. Delivery: coordinate delivery to appropriate locations (shop or field).
B. Acceptance at Site: Items individually packaged in manufacturers’ original containers, complete with proper fasteners and related pieces. Clearly mark packages to indicate contents, locations in hardware schedule and door numbers.

C. Storage: Provide locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, etc…

1.07 PROJECT CONDITIONS:
   A. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical as the same operation and quality as type specified, subject to Architect’s approval.

1.08 SEQUENCING AND COORDINATION:
   A. Coordinate with concrete.
   B. Reinforce walls.
   C. Coordinate finish floor materials and floor-mounted hardware.
   D. Conduit and raceways as needed for electrical, electronic and electro-pneumatic hardware items. Fire/life-safety system interfacing. Point-to-point wiring diagrams plus riser diagrams to related trades.
   E. Furnish manufacturer templates to door and frame fabricators.
   F. Use hardware consultant to check Shop Drawings for doors and entrances to confirm that adequate provisions will be made for proper hardware installation.
      1. Confirm that door manufacturers furnish necessary UBC-7-2 compliant seal packages.

1.09 WARRANTY:
   A. Part of respective manufacturers’ regular terms of sale. Provide manufacturers’ warranties:
      1. Closers: Ten years mechanical, 2 years electrical
      2. Exit Devices: Three years mechanical, 1 year electrical.
      3. Hinges: Life of Building.
      4. Locksets: Five years
      5. Other Hardware: Two years.

1.10 COMMISSIONING:
   A. Test door hardware operation with climate control system and stairwell pressurization system both at rest and while in full operation.
   B. Test electrical, electronic and electro-pneumatic hardware systems for satisfactory operation.
   C. Test hardware interfaced with fire/life-safety system for proper operation and release.

1.11 MAINTENANCE:
   A. Tools: After final adjustment of door hardware turn over to Owner tools. Furnished during construction used for installation and adjustment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Listed below are specified manufacturers and acceptable alternates:

<table>
<thead>
<tr>
<th>ITEM:</th>
<th>MANUFACTURER:</th>
<th>ACCEPTABLE SUB:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinges</td>
<td>(IVE) Ives</td>
<td>McKinney, Stanley</td>
</tr>
<tr>
<td>Pivots</td>
<td>(IVE) Ives</td>
<td>None - Owner Standard</td>
</tr>
<tr>
<td>Locks</td>
<td>(SCH) Schlage</td>
<td>None - Owner Standard</td>
</tr>
<tr>
<td>Push/Pull Latches</td>
<td>(GLY) Glynn Johnson</td>
<td>None</td>
</tr>
<tr>
<td>Push/Pull Plates</td>
<td>(IVE) Ives</td>
<td>None - Owner Standard</td>
</tr>
<tr>
<td>Push/Pull Sets</td>
<td>(IVE) Ives</td>
<td>Trimco</td>
</tr>
<tr>
<td>Pocket Door Pulls</td>
<td>(TRI) Trimco</td>
<td>None</td>
</tr>
<tr>
<td>Flush Pull</td>
<td>(TRI) Trimco</td>
<td>None</td>
</tr>
</tbody>
</table>
FINISH HARDWARE

Exit Devices  (VON) Von Duprin  None - Owner Standard
Electric Strikes  (VON) Von Duprin  None - Owner Standard
Closers  (LCN) LCN  None - Owner Standard
Wall/Floor Magnets  (IVE) Ives  Rixson
Keyswitches  (SCE) Schlage Electronics  Securitron
Overhead Stops  (GLY) Glynn Johnson  Rixson
Flush Bolts  (IVE) Ives  None - Owner Standard
Coordinators  (IVE) Ives  None - Owner Standard
Latch Guards  (IVE) Ives  None - Owner Standard
Roller Latches  (IVE) Ives  None - Owner Standard
Kickplates  (IVE) Ives  None - Owner Standard
Armor Plates  (IVE) Ives  None - Owner Standard
Astragals  (NGP) National Guard  Pemko
Stops  (IVE) Ives  Trimco
Weatherstrip  (NGP) National Guard  Pemko
Thresholds  (NGP) National Guard  Pemko
Sweeps  (NGP) National Guard  Pemko
Seals  (NGP) National Guard  Pemko
Door Bottoms  (NGP) National Guard  Pemko
Automatic Operators  (LCN) LCN  None - Owner Standard
ADA Door Actuators  (CRR) Curran  None - Owner Standard
Pocket Door Sets  (KNC) K.N. Crowder  Johnson
Sliding Hardware  (KNC) K.N. Crowder  Crown Industrial

B. Provide hardware items required to complete the work in accordance with these specifications and manufacturers’ instructions.
1. Include items inadvertently omitted from this specification. Note these items in submittal for review.
2. Where scheduled item is now obsolete, bid and furnish manufacturers updated item at no additional cost to the project.

2.02 HANGING MEANS:
A. Conventional Hinges: Hinge open widths minimum, but, of sufficient throw to permit maximum door swing. Steel or stainless steel pins and concealed bearings.
1. Three hinges per leaf to 7 foot, 0 inch height. Add one for each additional 30 inches in height, or any fraction thereof.
2. Heavy weight hinges on doors over 36” in width and doors with exit devices, 4 ½ x 4 ½.
4. Non-ferrous material exteriors and at doors subject to corrosive atmospheric conditions.
5. Provide shims and shimming instructions for proper door adjustment.

2.03 LOCKSETS, LATCHSETS, DEADBOLTS:
A. Locksets and Latchsets:
1. Schlage ND series.
2. Latchbolts: 1/2 inch throw at single doors and non-rated pairs, 5/8” at rated pairs.
3. Lever Trim: Rhodes design.
4. Strikes: ANSI 1-1/4” x 4-7/8” x 3/32” (10-025), lips of sufficient length to clear trim and protect clothing. Where pairs of door occur with flat bar astragal, provide lip length that allows installation of astragal without modification to strike.

2.04 EXIT DEVICES/PANIC HARDWARE
A. General features:
1. Independent lab-tested 1,000,000 cycles.
FINISH HARDWARE

3. ¾" throw deadlocking latch-bolts.
4. No exposed screws to show through glass doors.
5. Non-handed basic device design with center case interchangeable with all functions, no extra parts required to effect change of function.
6. Releasable with 32 lb. maximum pressure under 250 lb. load to the door.

B. Specific features:
2. Lever Trim: Breakaway type, forged brass or bronze escutcheon min .130” thickness, match lockset lever design.
3. Fire-Labeled Devices: UL label indicating “Fire Exit Hardware”. Provide rim exit devices at pair and single openings unless otherwise scheduled. Provide surface vertical rod exit devices at cross corridor pairs where wall mounted magnetic hold opens are scheduled.
4. Electrically Operated Devices: Single manufacturer source for electric latch retraction devices, electrically controlled trim, power transfers, power supplies, monitoring switches and controls.
5. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key. Furnish storage brackets for securely stowing the mullion away from the door when removed.

2.05 CLOSERS
A. Surface Closers:
1. Full rack-and-pinion type cylinder with removable non-ferrous cover and cast iron body.
3. Plates, brackets and special templating when needed for interface with particular header, door and wall conditions and neighboring hardware.
4. Opening pressure: Exterior doors 8.5 lb., interior doors 5 lb., labeled fire doors-minimum required to close and latch door.
5. Separate adjusting valves for closing speed, latching speed and backcheck, fourth valve for delayed action where scheduled.
6. Heavy duty arms (EDA) for doors scheduled with parallel arm units.

1. Self-contained low-voltage power supply, terminal strip and sequencing for incorporation of electric hardware with system operation.

2.06 OTHER HARDWARE
A. Flush Bolts: Low operating force design.
B. Kick Plates: Four beveled edges, .050 inches minimum thickness, height and width as scheduled. Sheet-metal screws of bronze or stainless steel to match other hardware.
C. Door Stops: Provide stops to protect walls, casework or other hardware.
1. Unless otherwise noted in Hardware Sets, provide wall type with appropriate fasteners. Where wall type cannot be used, provide floor type. If neither can be used, provide overhead type.

D. Thresholds: As scheduled and per details. Substitute products: certify that the products equal or exceed specified material’s thickness. Proposed substitutions: submit for approval.
1. Exteriors: Set in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements in Division 7 “Thermal and Moisture Protection”. Non-ferrous ¼ inch
FINISH HARDWARE

fasteners and lead expansion shield anchors, or Red-Head #SFS-1420 (or approved equivalent) Flat Head Sleeve Anchors (SS/FHSL).

2. Sound control openings: Set in bed of mastic sealant.

E. Fasteners: Generally, exposed screws to be Phillips or Robertson drive. Pinned TORX drive at high security areas. Flat head sleeve anchors (FHS/L) may be slotted drive. Sheet metal and wood screws: full-thread. Sleeve nuts: full length to prevent door compression.

F. Silencers: Interior hollow metal frames, 3 for single doors, 4 for pairs of doors. Omit where adhesive mounted seal occurs. Leave no unfilled/uncovered pre-punched silencer holes.

2.07 FINISH:

A. Generally BHMA 626 Satin Chromium.

1. Areas using BHMA 626 to have push-plates, pulls and protection plates of BHMA 630, Satin Stainless Steel, unless otherwise noted.

B. Door closers: factory powder coated to match other hardware, unless otherwise noted.

C. Aluminum items: match predominant adjacent material. Seals to coordinate with frame color.

2.08 KEYING REQUIREMENTS:

A. Key System: Existing Schlage Primus Key System. Cylinder cores, keys and keying provided by Owner.

B. Interchangeable Core cylinders at all cylinders, with keyed construction cores installed.

C. Permanent cores: furnished by Owner.

D. Permanent keys and cores: furnished by Owner.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS:

A. Factory trained, certified, and carries a factory-issued card certifying that person as a “Certified Installer”. Alternative: can demonstrate suitably equivalent competence and experience.

3.02 PREPARATION:

A. Ensure that walls and frames are square and plumb before hardware installation.

B. Clarify placement if new hardware is to be installed near existing doors/hardware scheduled to remain.

C. Mounting Heights: Locate hardware units at heights indicated in DHI’s recommended locations unless otherwise indicated or required to comply with governing regulations.

D. Existing frames and doors scheduled to receive new hardware: carefully remove existing hardware, tag and bag, and turn over to Owner.

1. Patch and fill wood frames and doors with solid wood stock or dowel material before cutting for new hardware. Do not reuse existing screw holes - fill and re-pilot.

2. Metal doors/frames: Weld or fasten with screws: filler pieces in existing hardware cut-outs and mortises not scheduled for re-use by new hardware. Leave surfaces smooth - no applied patches.

3.03 INSTALLATION:

A. Install hardware per manufacturer’s instructions and recommendations. Do not install surface-mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation.

1. Gaskets: install jamb-applied gaskets before closers, overhead stops, rim strikes, etc. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.

2. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.

B. Locate floor stops not more than 4 inches from the wall.
FINISH HARDWARE

C. Drill pilot holes for fasteners in wood doors and/or frames.
D. Lubricate and adjust existing hardware scheduled to remain. Carefully remove and give to Owner items not scheduled for reuse.

3.04 ADJUSTING
A. Adjust and check for proper operation and function. Replace units, which cannot be adjusted to operate freely and smoothly.
   1. Hardware damaged by improper installation or adjustment methods to be repaired or replaced to Owner's satisfaction.
B. Inspection: Use hardware supplier. Include suppliers with closeout documents.
C. Follow-up inspection: Installer to provide letter of agreement to Owner that approximately 6 months after substantial completion, installer will visit Project with representatives of the manufacturers of the locking devices and door closers to accomplish following:
   1. Re-adjust hardware.
   2. Evaluate maintenance procedures and recommend changes or additions, and instruct Owner's personnel.
   3. Identify items that have deteriorated or failed.

3.05 DEMONSTRATION:
A. Demonstrate electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

3.06 PROTECTION/CLEANING:
A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to substantial completion.
B. Clean adjacent wall, frame and door surfaces soiled from installation/reinstallation process.

3.07 SCHEDULE OF FINISH HARDWARE
A. See door schedule in drawings for hardware set assignments.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass.
B. Glazing compounds and accessories.

1.02 DEFINITIONS

A. ASHRAE NFRC 2001 Terms and abbreviations:
   1. U-Value = U-Factor, winter.
   2. VTL = Visible Light Transmittance.
   3. SHGC = Solar Heat Gain Coefficient.

B. Safety Glazing: Laminated glass complying with ASTM C 1172, and testing requirements of 16 CFR 1201, Category II or tempered glass complying with ASTM C 1048, and testing requirements of CPSC 16 CFR 1201.

C. Glazing conditions requiring safety glazing by code or local authority having jurisdiction.

1.03 PERFORMANCE REQUIREMENTS

A. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
   1. In conjunction with vapor retarder and joint sealer materials described in other sections.
   2. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

B. Select type and thickness of all glass and glass units to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with building code.
   1. Use the procedure specified in ASTM E 1300 to determine glass type and thickness.
   2. Limit center-of-glass deflection to the smallest of the following:
      a. The displacement associated with the structural capacity of the glazing unit.
      b. L/100, where L is the shortest side dimension of the unit measured in inches.
      c. 3/4 inch.
   3. Thermal Loading: Design glass to resist thermal loads at service including those induced by differential shading within individual lites.
   4. Thicknesses listed are minimum.

C. Safety Glazing: Provide safety glazing of type indicated at glazing conditions where shown and where additionally required by authorities having jurisdiction.

D. Heat Strengthening and Tempering: Flatness for 6mm glass panels shall not exceed 0.0030 inches for localized deformation.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors of exposed materials for selection by Architect.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
   1. Delegated Design Data: See Section 01 33 16.

E. Samples: Submit two samples 12 by 12 inch in size of glass and plastic units, showing coloration and design.

F. Samples: Submit 8 inch long bead of glazing sealant, selected or available color.

G. Manufacturer's Certificates: Certify that products meet or exceed specified requirements.
H. Installer's Qualifications.
   I. Sample Warranties.

1.05 QUALITY ASSURANCE
   B. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
   C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
   D. Source Limitations for Glass: Obtain ultraclear float glass tinted float glass coated float glass laminated glass and insulating glass from single source from single manufacturer for each glass type.
   E. IGU Fabricator: Company whose location, equipment, and processes are certified by the coated glass manufacturer.
   F. Installer Qualifications: Company specializing in performing the work of this section with minimum 10 years documented experience.
      1. A qualified installer who employs glass installers for this Project who are certified under the National Glass Association’s Certified Glass Installer Program.

1.06 MOCK-UP
   A. See Section 01 40 00 - Quality Requirements, for additional mock-up requirements.
   B. Provide mockup of glazing system including glass and air barrier and vapor retarder seal.
   C. Locate where directed.
   D. Mockup may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING
   A. Convene meeting prior to fabrication of glazing units and coordinate with meetings for glazing framing systems work.

1.08 FIELD CONDITIONS
   A. Do not install glazing when ambient temperature is less than 50 degrees F.
   B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Sealed Insulating Glass Units: Provide a ten (10) year warranty to include coverage for seal failure, interpane dusting or misting, deterioration of coatings(s); and to provide for replacement of failed units. Deterioration of coated glass is defined as peeling, cracking, or related defects developed from normal use that are not associated with breakage or with actions in violation of written guidance from the manufacturer. Warranty to cover all costs associated with full replacement of failed units.
   C. Laminated Glass Units: Provide manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by ASTM C 1172 Standard Specification for Laminated Architectural Flat Glass. Warranty to cover all costs associated with full replacement of failed units.
PART 2 PRODUCTS

2.01 GENERAL GLASS REQUIREMENTS

A. Glass Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
   1. Minimum Glass Thickness for Exterior Lites: Not less than [6.0] mm.
   2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Exposed Edges of Glass: Ground and polished.

D. IGU Performance Properties:
   1. U-Factors (Winter): Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
      a. IGU must meet minimum code requirements for U-Value of 0.30.
   2. Solar Heat-Gain Coefficient (SHGC), Visible Light Transmittance (VLT), and Ultraviolet Transmittance (UVT): Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
      a. IGU must meet minimum code requirements for SHGC of 0.40.
   3. Visible Light Reflectance: Center-of-glazing values, according to NFRC 300.
   4. Sound Transmission Class, STC, when tested per ASTM E 90.
   5. Assure that edge seal is compatible with glazing system.

2.02 GLASS MATERIALS

A. Float Glass: ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select), unless otherwise indicated.
   1. Float Glass Manufacturers:
      e. Substitutions: Refer to Section 01 60 00 - Product Requirements.

B. Heat-Strengthened and Fully Tempered Float Glass: ASTM C 1048; Type I; Quality-Q3; of class, kind and condition indicated; horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed.
   1. Maximum roll wave distortion from top to bottom of wave as measured using calibrated industry accepted equipment: 0.005 inch.
   2. Structurally Butt Glazed Glass: Delegated design for thickness and span, and bright flat polished edges joined vertically with silicone sealant, and at perimeter, stopped into hollow metal frame.
      a. Operational Loads: Designed to withstand imposed human impact pressure under normal traffic without damage, racking, sagging, or deflection.

C. Uncoated Tinted Float Glass: Class 2, complying with other requirements specified, manufacturer, product, and color as scheduled.

2.03 LAMINATED GLASS UNITS

A. Laminated Glass: Float glass, heat strengthened float glass, or fully tempered float glass laminated in accordance with ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
1. Laminated Safety Glass: Comply with 16 CFR 1201 test requirements for Category II.
2. Plastic Interlayer: Polyvinyl butyral, 0.030 inch thick, unless otherwise indicated, or required by performance requirements.
3. Where fully tempered is specified or required, provide glass that has been tempered by the tong-less horizontal method.

2.04 SEALED INSULATING GLASS UNITS
A. Fabricator/Manufacturers: Certified by coated glass manufacturer.
B. Sealed Insulating Glass Units: Types as indicated.
   1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
   2. Edge Spacers: Aluminum, clear anodized finish, bent and soldered corners.
   3. Edge Seal: Glass to elastomer with supplementary silicone sealant.
   4. Purge interpane space with dry hermetic air.
   5. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.

2.05 GLAZING COMPOUNDS
A. Manufacturers:
   5. Substitutions: Refer to Section 01 60 00 - Product Requirements.
B. Butyl Sealant: Single component; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; Shore A hardness of 10 to 20; black color; non-skinning.
C. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C 920, Type S, Grade NS, Class 100/50 selected color.

2.06 GLAZING ACCESSORIES
A. Setting Blocks: EPDM, 80 to 90 Shore A durometer hardness, ASTM C 864 Option I. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.
B. Spacer Shims: EPDM, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.
C. Glazing Tape: Preformed butyl compound with integral resilient tube spacing device; 10 to 15 Shore A durometer hardness; coiled on release paper; black color.
   1. Manufacturers:
      c. Substitutions: Refer to Section 01 60 00 - Product Requirements.
D. Glazing Channels: Design Basis CR Lawrence or approved.
E. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C 864 Option I; selected color.
F. Glazing Clips: Manufacturer's standard type.

2.07 LAMINATED GLASS TYPES
A. Glass Type LG#1: Clear laminated glass.
   1. Outer and Inner Ply: 3-mm heat strengthened float glass.
   2. Unit Thickness: 6.0 mm.
   3. Interlayer Thickness: 0.030- inch.
   4. Provide safety glazing labeling.
B. Glass Type LG#2: Clear laminated glass.
   1. Outer Ply: 3-mm fully-tempered coated float glass.
      a. Coating: Scratch resistant coating on No. 1 surface.
   2. Inner Ply: 3-mm fully-tempered coated float glass.
      a. Coating: Scratch resistant coating on No. 4 surface.
   3. Unit Thickness: 6.0 mm.
   4. Interlayer Thickness: 0.030- inch.
   5. Provide safety glazing labeling.
   6. Application: Entry doors and as indicated.

2.08 INSULATED GLASS UNIT TYPES
A. Glass Type IGU-1, IGU-2, IGU-3: High-performance, low-e-coated, solar control clear
   insulating glass.
   1. Overall Unit Thickness: 1 inch (25 mm).
   2. Thickness of Each Glass Lite: 1/4 inch (6.0 mm).
   3. Outdoor Lite: Float glass, except heat-strengthened float glass where required, and fully
      tempered float glass where required or as indicated.
   4. Interspace Content: Air.
   5. Indoor Lite: Float glass, except heat-strengthened float glass where required, and fully
      tempered float glass where indicated.
   6. Visible Light Transmittance: 60 to 65 percent.
   7. Winter Nighttime U-Factor: 0.30 maximum.
   8. Solar Heat Gain Coefficient: 0.27 to 0.30.
   9. Provide safety glazing labeling where required.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that openings for glazing are correctly sized and within tolerance.
B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may
   impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION
A. Clean contact surfaces with solvent and wipe dry.
B. Prime surfaces scheduled to receive sealant.
C. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.
D. Install sealant in accordance with manufacturer’s instructions.

3.03 INSTALLATION - EXTERIOR DRY METHOD (GASKET GLAZING)
A. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
B. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to
   attain full contact.
C. Install removable stops without displacing glazing gasket; exert pressure for full continuous
   contact.

3.04 INSTALLATION - INTERIOR BUTT GLAZED METHOD (SEALANT ONLY)
A. Temporarily brace glass in position for duration of glazing process. Mask edges of glass at
   adjoining glass edges and between glass edges and framing members.
B. Temporarily secure a small diameter non-adhering foamed rod on back side of joint.
C. Apply sealant to open side of joint in continuous operation; thoroughly fill the joint without
   displacing the foam rod. Tool the sealant surface smooth to concave profile.
D. Permit sealant to cure then remove foam backer rod. Apply sealant to opposite side, tool
   smooth to concave profile.
E. Remove masking tape.
3.05 INSTALLATION - INTERIOR DRY METHOD (TAPE AND TAPE)
A. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
C. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
D. Place glazing tape on free perimeter of glazing in same manner described above.
E. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
F. Knife trim protruding tape.

3.06 INSTALLATION - INTERIOR WET/DRY METHOD (TAPE AND SEALANT)
A. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
C. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.
D. Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch intervals, 1/4 inch below sight line.
E. Fill gaps between pane and applied stop with silicone type sealant to depth equal to bite on glazing, to uniform and level line.
F. Trim protruding tape edge.

3.07 MANUFACTURER'S FIELD SERVICES
A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
B. Monitor and report installation procedures and unacceptable conditions.

3.08 CLEANING
A. Remove glazing materials from finish surfaces.
B. Remove labels after Work is complete.
C. Clean glass and adjacent surfaces.
D. Smoke Removal Targets: Install in accordance with approved shop drawings and direction of authorities having jurisdiction.

3.09 PROTECTION
A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

3.10 SCHEDULE
A. GL-1
   1. Location: Student Street
   2. Manufacturer: TBD
   3. Product: Clear Channel-set Glass, Tempered
   4. Notes: Gray Sealant
B. GL-2
   1. Location: Student Street
   2. Manufacturer: TBD
   3. Product: Channel set laminated glass with opaque color at inner laminate surface(s)
   4. Color: TBD
   5. Notes: Gray Sealant
C. GL-3
   1. Location: Student Street Marker Boards / TV surrounds
   2. Manufacturer: TBD
   3. Product: Channel set laminated glass with opaque color at inner laminate surface(s)
   4. Color: 2 (white)

D. GL-4
   1. Location: Student Street
   2. Manufacturer: TBD
   3. Product: Back painted safety glass, painted white, mounted on standoffs, pencil ground edges.

E. GL-5 (NOT USED)
F. GL-6 (NOT USED)
G. GL-7 (NOT USED)
H. GL-8 (NOT USED)
I. GL-9 (NOT USED)
J. GL-10
   1. Location: Existing Windows
   2. Manufacturer: TBD
   3. plate glass, tempered, etched
   4. Product: Existing window repair

K. GL-11
   1. Location: Existing Windows
   2. Manufacturer: TBD
   3. ¼" plate glass, tempered, etched
   4. Product: Existing window repair

L. GL-12
   1. Location: Fire Rated Glass in HM Doors
   2. Manufacturer: TBD
   3. Product: 45 Min Rated Glass

M. IGU-1
   1. Location: Curtainwall Glazing, South and East
   2. Manufacturer: Viracon
   3. Model: VNE-163
   4. VLT: 0.62
   5. Shading Coefficient: 0.29
   6. LSG Ratio: 2.14
   7. U-Value Winter - Center of Glass: .029 maximum

N. IGU-2
   1. Location: Curtainwall Glazing, North and West
   2. Manufacturer: Viracon
   3. Model: VE1-2M
   4. VLT: 0.7 minimum
   5. Shading Coefficient: 0.38 minimum
   6. LSG Ratio: 1.84
   7. U-Value Winter - Center of Glass: .029
   8. Air Fill

O. IGU-3
   1. Location: Multifunctional Auditorium
   2. Manufacturer: TBD
   3. Model: TBD
4. 1 inch Spandrel
5. Low Iron Glass
6. U-Value Winter - Center of Glass: .029 maximum
7. Air Fill

P. IGU-4
1. Location: Skylight 1 and 2
2. Basis of Design Manufacturer: TBD
3. Basis of Design Model: TBD
4. VLT: 0.x minimum
5. Shading Coefficient: 0.30 maximum
6. LSG Ratio: 1.84
7. Frit pattern: 1/8" dots, 30 percent coverage
8. U-Value Winter - Center of Glass: 0.29 maximum
9. Air Fill

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Glass mirrors.

1.02 REFERENCE STANDARDS
   A. GANA (TIPS) - Mirrors Handle with Extreme Care: Tips For the Professional on the Care and Handling of Mirrors; National Association of Mirror Manufacturers; 2004 (http://www.mirrorlink.org-members/technical.html)

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data on Mirror Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
   C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   D. Manufacturer's Certificate: Certify that mirrors, meets or exceeds specified requirements.
   E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE
   A. Perform Work in accordance with GANA Glazing Manual for glazing installation methods.
   B. Fabricate, store, transport, receive, install, and clean mirrors in accordance with recommendations of GANA (TIPS) "Mirrors Handle with Extreme Care: Tips For the Professional on the Care and Handling of Mirrors."

1.05 FIELD CONDITIONS
   A. Do not install mirrors when ambient temperature is less than 50 degrees F.
   B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.06 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for reflective coating on mirrors and replacement of same.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Mirror Glass - General: Select materials and/or provide supports as required to limit mirrored glass deflection to 1/200 or flexure limit of glass with full recovery of glazing materials, whichever is less.
   B. Mirror Glass: Clear tempered safety type with copper and silver coating, organic overcoating, square and lapped edges, 6 mm thick minimum.
      1. Sizes noted on Drawings.
2.02 GLAZING ACCESSORIES
   A. Mirror Attachment Accessories: Stainless steel clips.
   B. Mirror Adhesive: Chemically compatible with mirror coating and wall substrate.

PART 3 EXECUTION
3.01 INSTALLATION - GENERAL
   A. Install mirrors in accordance with GANA recommendations.
   B. Set mirrors plumb and level, free of optical distortion.
   C. Set mirrors with edge clearance free of surrounding construction including countertops or backsplashes.

3.02 CLEANING
   A. Remove wet glazing materials from finish surfaces.
   B. Remove labels after work is complete.
   C. Clean mirrors and adjacent surfaces.

3.03 PROTECTION
   A. After installation, mark pane with an 'X' by using removable plastic tape or paste.
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Louvers, frames, and accessories (metal panel matching profile at North Wing penthouse; see Section 07 42 13).

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames.
D. Samples: Submit two samples 2 by 2 inches in size illustrating finish and color of exterior and interior surfaces.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
F. Test Reports: Independent agency reports showing compliance with specified performance criteria.
G. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum 3 years of documented experience.

1.05 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide twenty year manufacturer warranty against distortion, metal degradation, and failure of connections.
   1. Finish: Include coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Wall Louvers:
5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LOUVERS
A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified under AMCA 511.
   1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
   2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
   3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
   4. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.
B. Stationary Louvers: Horizontal blade, extruded aluminum construction, with intermediate mullions matching frame.
   1. Free Area: 50 percent, minimum.
   2. Blades: Drainable.
   3. Frame: 4 inches deep, channel profile; corner joints mitered and, with continuous recessed caulking channel each side.
   4. Metal Thickness: Frame 0.081 inch; blades 0.081 inch.
   5. Finish: Polyvinylidene fluoride coating; finish welded units after fabrication.
   6. Color: Custom, to match approved sample.

2.03 MATERIALS
A. Extruded Aluminum: ASTM B221 (ASTM B221M),
B. Bird Screen: Interwoven wire mesh of steel, 0.063 inch diameter wire, 1/2 inch open weave, diagonal design.
C. Insect Screen: 18 x 16 size aluminum mesh.
D. Polyvinylidene Fluoride Coating: Minimum 70 percent Kynar 500/Hylar 500 resin, two coat finish, complying with AAMA 2605.
   1. Finish: Custom color to match metal panels; see Section 07 42 13.

2.04 ACCESSORIES
A. Blank-Off Panels: Same material as louver, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.
B. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.
C. Fasteners and Anchors: Stainless steel.
D. Flashings: Of same material as louver frame, formed to required shape, single length in one piece per location.
E. Sealant: Exterior silicone building joint type, as specified in Section 07 90 05.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.

3.02 INSTALLATION
A. Install louver assembly in accordance with manufacturer's instructions.
B. Install louvers level and plumb.
C. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
D. Secure louver frames in openings with concealed fasteners.
E. Install perimeter sealant and backing rod in accordance with Section 07 90 05.

3.03 CLEANING

A. Strip protective finish coverings.
B. Clean surfaces and components.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.
B. Metal framing for interior partitions, ceilings and soffits.
C. Resilient sound isolation components.
D. Metal channel ceiling framing.
E. Metal suspension systems.
F. Shaft wall system.
G. Acoustic insulation.
H. Gypsum wallboard.
I. Joint treatment and accessories.

1.02 DEFINITIONS

A. Exit Enclosures:
B. Interior, Wet Areas: Toilet room, bath room, shower, janitor closet, laundry room, walls within indicated distance behind or adjacent to a sink, trash room, recycle room, and exterior; see construction assemblies on drawings for diagrams indicating distances.
C. Exterior Wet Areas: see construction assemblies on drawings for diagrams indicating distances.
D. Steel Thickness: Minimum base metal thickness per SSMA.
E. High-Rise Building: A building with an occupied floor located more than 75 feet (22, 860mm) above the lowest level of fire department vehicle access.

1.03 SYSTEM DESCRIPTION

A. Acoustic Attenuation for Interior Partitions Indicated as Acoustic: STC of value indicated in Drawings calculated in accordance with ASTM E 413, based on tests conducted in accordance with ASTM E 90.
B. Shaft Wall: Configure and install components as required to achieve the following performance levels:
   1. Air Pressure Within Shaft: Intermittent loads of 10 lbf/sq ft with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 40-44 calculated in accordance with ASTM E 413, based on tests conducted in accordance with ASTM E 90.
C. High-rise buildings of occupancy category III or IV in accordance with Section 1604.5, and for all buildings that are more than 420 feet (128 m) in building height, exit enclosures and elevator hoistway enclosures shall comply with Sections 403.2.3.1 through 403.2.3.4.
   1. 403.2.3.1 Wall assembly. The wall assemblies making up the exit enclosures and elevator hoistway enclosures shall meet or exceed Soft Body Impact Classification Level 2 as measured by the test method described in ASTM C 1629/C 1629M.
   2. 403.2.3.2 Wall Assembly Materials. The face of the wall assemblies making up the exit enclosures and elevator hoistway enclosures that are not exposed to the interior of the exit enclosure or elevator hoistway enclosure shall be constructed in accordance with one of the following methods:
      a. The wall assembly shall incorporate not less than two layers of impact-resistant construction board each of which meets or exceeds Hard Body Impact Classification Level 2 as measured by the test method described in ASTM C 1629/C 1629M.
      b. The wall assembly shall incorporate not less than two layers of impact-resistant construction board each of which meets or exceeds Hard Body Impact Classification Level 2 as measured by the test method described in ASTM C 1629/C 1629M.
c. The wall assembly shall incorporate not less than two layers of impact-resistant construction board each of which meets or exceeds Hard Body Impact Classification Level 2 as measured by the test method described in ASTM C 1629/C 1629M.

3. 403.2.3.3 Concrete and Masonry Walls. Concrete or masonry walls shall be deemed to satisfy the requirements of Sections 403.2.3.1 and 403.2.3.2.

4. 403.2.3.4 Other wall assemblies. Any other wall assembly that provides impact resistant equivalent to that required by 403.2.3.1 and 403.2.3.2 for Hard Body Impact Classification Level 2 as measured by the test method described in ASTM C 1629/C 1629M.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.
C. Product Data: Provide data on metal framing, gypsum board, glass mat faced gypsum board, accessories, and joint finishing system.
D. Product Data: Provide manufacturer’s data on partition head to structure connectors, showing compliance with requirements.
E. Samples: Submit two samples of gypsum board finished with proposed texture application, 12 by 12 inches in size, illustrating finish color and texture.
F. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers’ product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.

1.05 QUALITY ASSURANCE
A. Perform in accordance with ASTM C 754, ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies. Comply with more stringent recommendations of Northwest Wall and Ceiling Bureau (NWCB).
   1. Maintain one copy of standards at project site.
B. Provide acoustically rated assemblies in compliance with listings for ratings indicated.
C. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 5 years of documented experience.
D. Copies of Documents at Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.06 REGULATORY REQUIREMENTS
A. Conform to applicable code for fire rated assemblies as indicated on drawings.
B. Brace and restrain ceilings as required by building code and AHJ.

PART 2 PRODUCTS
2.01 GYPSUM BOARD ASSEMBLIES
A. Provide completed assemblies complying with ASTM C840 and GA-216.
   1. See PART 3 for finishing requirements.
B. Interior Partitions Indicated as Acoustic: Provide completed assemblies with the following characteristics:
1. Acoustic Attenuation: STC of 55-59 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
   1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

D. Shaft Walls at Elevator Shafts: Provide completed assemblies with the following characteristics:
   1. Air Pressure Within Shaft: Intermittent loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
   2. Acoustic Attenuation: STC of 50-54 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

E. Fire Rated Assemblies: Provide completed assemblies as indicated conforming to listing agencies specifications and complying with applicable code and jurisdictional requirements.

2.02 METAL FRAMING MATERIALS

A. Manufacturers - Metal Framing, Connectors, and Accessories: Member of SSMA or GA. Subject to compliance with requirements, provide cold-formed metal framing by one of the following:
   7. Steeler Inc.: www.steeler.com
   9. Substitutions: See Section 01 60 00 - Product Requirements.

B. Interior Non-Loadbearing Framing System Components: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf, except L/720 at 5 psf for ceramic tile, stone tile, stone veneer and upper casework or other heavy attachment.
   1. Studs: "C" shaped with flat or formed webs with knurled faces.
   2. Runners: U shaped, sized to match studs.
   3. Ceiling Channels: C shaped.
   4. Furring: Hat-shaped sections, minimum depth of 7/8 inch or as indicated.
   5. Resilient Furring Channels: 1/2 inch depth, for attachment to substrate through one leg only.
      a. Manufacturers - Resilient Furring Channels:
         1) Same manufacturer as other framing materials.
   6. Resilient Channel: Assymetric-shaped channel with face connected to single flange by single leg with alternating slots, 1/2 inch deep.
   7. Supplementary framing.
   8. Bracing, bridging, and solid blocking.
   10. Anchor clips.
   11. End clips.
   12. Foundation clips.
   15. Joist hangers and end closures.
   17. Backer plates.
C. Loadbearing Studs for Application of Gypsum Board: As specified in Section 05 40 00.

D. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
   1. Manufacturers - Shaft Wall Studs and Accessories:
      a. Same manufacturer as other framing materials.

E. Shaft Wall Studs and Accessories: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 and specified performance requirements.

F. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

G. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and screwed to secondary deflection channel set inside but unattached to top track.

H. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
   1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
   3. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings.
   4. Deflection and Firestop Track:
      a. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-rating of the wall assembly.
      b. Acceptable Products:
         1) "Posi Klip" by Fire Trak Corporation.
         2) Doubletrack System by ClarkDietrich, top track painted black where visible.
         3) HW-D-0060 by Fire Trak.
   5. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 12 feet.

2.03 PRE-ENGINEERED DRYWALL SUSPENSION SYSTEM
   A. independently supported
   B. light fixtures, and air diffusers
   C. Interior Non-Loadbearing Suspension System: Cold-rolled steel, hot dipped galvanized finish, of size and properties necessary to comply with the spacing indicated and as engineered by manufacturer, with maximum deflection of ceiling framing system

2.04 RESILIENT SOUND ISOLATION COMPONENTS
   B. Wall Isolation Clips: Resilient Sound Isolation Clip (RSIC-V).
   C. Ceiling Isolation Clips: Resilient Sound Isolation Clip (RSIC-EXT04).
   1. Rubber Isolator: Natural organic rubber compound, blended with fire-inhibiting compounds. Molded to isolate ferrule from clip. Minimum of 12 micro-vibration controlling pedestals at point of contact with framing member. Manufactured to ASTM D 2000, M2 AA 510 A13, which includes:
      b. Modulus 300 Percent, ASTM D 412, Die C: 5.3 MPa.
      d. Elongation at Break, ASTM D 573: 454 percent.
   2. Clip: Galvanized or aluminum-zinc coated steel, 16 gauge.
4. Projection: 1-5/8 inches from supporting structure, when 7/8-inch drywall furring channels are used.
5. Mechanical Fasteners: As recommended by manufacturer.
6. Acoustic Sealant: As specified in Section 07920.

2.05 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
9. Substitutions: See Section 01 60 00 - Product Requirements.

B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. Glass-mat-faced gypsum panels as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
3. Unfaced fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
4. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.
   b. Mold-resistant board is required at all locations.
5. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
6. Thickness:
   b. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
   c. Edges: Tapered.

C. Impact-Rated Wallboard: Tested to Level 3 soft-body and hard-body impact in accordance with ASTM C1629.
1. Application: High-traffic areas indicated.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Paper-Faced Type: Gypsum wallboard as defined in ASTM C1396/C1396M.
4. Unfaced Type: Interior fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M.
5. Type: Fire-resistance rated Type X, UL or WH listed.

D. Backing Board For Wet Areas:
1. Application: Surfaces behind tile, wet areas as defined, and including tub and shower surrounds and shower ceilings.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Glass-Mat-Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178.
   b. Edges: Tapered.
   c. Fire-Resistant Type: Type X core, thickness 5/8 inch.
Gypsum Board Assemblies

E. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
   1. Application: Vertical surfaces behind thinset tile, except in wet areas.
   2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   3. Type: Regular and Type X, in locations indicated.
   4. Type X Thickness: 5/8 inch.
   5. Type C Thickness: 1/2 inch.

F. Ceiling Board: Special sag-resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 5/8 inch.

G. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings and soffits in wet areas, unless otherwise indicated.
   2. Core Type: Regular and Type X, as indicated.

H. Exterior Sheathing Board: As specified in Section 06 10 00.

I. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
   1. Paper Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C 1396/C 1396M; water-resistant faces.
   2. Glass Mat Faced Type: Glass mat shaftliner gypsum panel or glass mat coreboard gypsum panel as defined in ASTM C 1658/C 1658M.
   3. Mold Resistance: Score of 10, when tested in accordance with ASTM D 3273.
   4. Products:
      a. American Gypsum; Shaft Liner.
      b. CertainTeed Corporation; ProRoc Brand Shaftliner Type X.
      c. Georgia-Pacific Gypsum LLC; DensGlass Shaftliner (mold-resistant).
      d. National Gypsum Company; Gold Bond Brand 1" Fire-Shield Shaftliner.
      e. National Gypsum Company; Gold Bond Brand 1" Fire-Shield Shaftliner XP (mold-resistant).
      f. Pacific Coast Building Products, Inc; PABCORE Gypsum Shaftliner Board type X.
      g. Temple-Inland Inc; SilentGuard Gypsum Shaftliner.
      h. USG Corporation; Sheetrock Gypsum Liner Panels.
      i. USG Corporation; Sheetrock Gypsum Liner Panels--Enhanced (mold-resistant).
      j. Substitutions: See Section 01 60 00 - Product Requirements.

J. Gypsum Shaftwall or Coreboard: ASTM C 1396/C 1396M; Type X core; sizes to minimize joints in place; 1 inch thick; square, tongue and groove, or double beveled edges, ends square cut.

2.06 ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: 3-1/2 inches.
   1. Green Guard label, and without formaldehyde.

B. Acoustic Sealant: As specified in Section 07 90 05.

C. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless otherwise indicated.
   1. Types: As detailed or required for finished appearance.
2. Special Shapes: In addition to conventional cornerbead and control joints, provide U-bead at exposed panel edges.
3. Manufacturers - Finishing Accessories:
   a. Same manufacturer as framing materials.
   c. Substitutions: See Section 01 60 00 - Product Requirements.

D. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
   1. Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.

E. High Build Drywall Surfacer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.
   1. Product: Tuff-Hide manufactured by USG or approved equivalent.

F. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.

G. Screws for Attachment to Steel Members From 0.033 to 0.112 Inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.

H. Screws: ASTM C 1002; self-piercing tapping type, anticorrosive-coated at wet areas.

I. Screws: ASTM C 954; steel drill screws for application of gypsum board to 40 mil and greater steel studs, anticorrosive-coated.


K. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

L. Adhesive for Attachment to Wood: ASTM C557.

M. Exterior Soffit Vents: One piece, perforated, ASTM B 221 6063 T5 alloy aluminum, with edge suitable for direct application to gypsum board and manufactured especially for soffit application. Provide continuous vent.

N. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   1. Manufacturers:
      a. Fry Reglet.
   2. Reveal: "Z" Reveal Molding.

O. "J" Molding by Fry Reglet - to occur everywhere the end of gb does not come to an intersection or already have an alternate called out.

P. "F" Reveal by Fry Reglet.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
   1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
   2. Install studs at spacing required to meet performance requirements.

B. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.
   1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
2. Seal perimeter of shaft wall and penetrations with fire stopping and acoustical sealant appropriate for UL listing.
3. Provide deflection head product or detail for 3/4 inch deflection, unless indicated otherwise.

### 3.03 FRAMING INSTALLATION

A. **Metal Framing:** Install in accordance with ASTM C754 and manufacturer's instructions.

B. **Suspended Ceilings and Soffits:** Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/1200.
   2. Laterally brace and vertically constrain entire suspension system.
   3. Install bracing as required at exterior locations to resist wind uplift.

C. **Studs:** Space studs at 16 inches on center, unless indicated otherwise.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. **Partitions Terminating at Ceiling:** Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
   3. **Partitions Terminating at Structure:** Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
   4. **Partitions Terminating at Structure:** Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
   5. Provide not less than 43 mil thick studs supporting wall cabinets and similar high wall loads. Refer to casework specification for design load.
   6. Provide not less than 54 mil thick studs supporting plumbing fixtures, counter tops and similar low wall-hanging loads. In addition to dead load, support 300 pound live load located anywhere on supported item.

D. **Openings:** Reinforce openings as required for weight of doors or operable panels, using not less than double 33 mil studs at jambs.

E. **Standard Wall Furring:** Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
   1. **Orientation:** Horizontal.
   2. **Spacing:** As indicated.

F. **Acoustic Furring:** Install resilient channels at maximum 24 inches on center, unless indicated otherwise.
   1. Locate joints over framing members.
   2. Orient open leg facing up to receive gypsum board.

G. **Furring for Fire Ratings:** Install as required for fire resistance ratings indicated and to GA-600 requirements.

H. **Blocking:** Install wood blocking for support of:
   1. Framed openings.
   2. Wall mounted cabinets.
   3. Plumbing fixtures.
   4. Toilet partitions.
   5. Toilet accessories.
   6. Wall mounted door hardware.

I. **Blocking:** Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, wood frame openings, toilet accessories, hardware, and other items as indicated. Comply with Section 06 10 00 for wood blocking with kerf for flange return.
   1. **Metal Blocking (where approved):** Continuous 6 inch 43 mil track with legs cut at supports.
3.04 ACOUSTIC ACCESSORIES INSTALLATION
A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
B. Acoustic Sealant: Install in accordance with manufacturer's instructions.
   1. Place one bead continuously on substrate before installation of perimeter framing members.
   2. Place continuous bead at perimeter of each layer of gypsum board.
   3. In non-fire-rated construction, seal around all penetrations by conduit, pipe, ducts, and rough-in boxes.

3.05 BOARD AND GLASS MAT FACED BOARD INSTALLATION
A. Comply with most stringent of NWCB, ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
B. Single-Layer Non-Rated: Install gypsum board parallel to framing, with ends and edges occurring over firm bearing.
   1. Exception: Tapered edges to receive joint treatment at right angles to framing.
C. Double-Layer Non-Rated: Use gypsum board for first layer, placed perpendicular to framing or furring members, with ends and edges occurring over firm bearing. Place second layer parallel to framing or furring members. Offset joints of second layer from joints of first layer.
D. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
E. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.
   1. Paper-Faced Sheathing: Immediately after installation, protect from weather by application of water-resistive barrier.
F. Exterior Soffits: Install exterior soffit board perpendicular to framing, with staggered end joints over framing members or other solid backing.
G. Installation on Metal Framing: Use screws for attachment of all gypsum board.
H. Installation on Wood Framing: For rated assemblies, comply with requirements of listing authority. For non-rated assemblies, install as follows:
   2. Double-Layer Application: Install base layer using screws or nails. Install face layer using adhesive.
I. Air Barrier Seal: Continuously seal joint between gypsum board and top plate of exterior walls. Provide continuous perimeter sealant joint and sealant joint at all penetrations of upper most ceiling. Seal other joints and gaps to assure complete and continuous air seal.
   1. Refer to Section 07 27 00 for continuous air and weather barrier system.
   2. Refer to building section drawings for additional information.
J. Attach gypsum board to resilient channels between framing members.
K. Curved Surfaces: Apply gypsum board to curved substrates in accordance with GA-226.
L. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board and exterior gypsum soffit board with sealant.

3.06 INSTALLATION OF TRIM AND ACCESSORIES
A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
   1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
B. Corner Beads: Install at external corners, using longest practical lengths.
C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.
D. Exterior Soffit Vents: Install according to manufacturer's written instructions and in locations shown on the drawings. Provide vent area specified.
3.07 JOINT TREATMENT


B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   2. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
   3. Level 3: Walls to receive textured wall finish.
   4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   5. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
   6. Level 0: Temporary partitions and surfaces indicated to be finished in later stage of project.

C. Finish all gypsum board in accordance with ASTM C 840/NWCB Level 4 smooth, except where level 5 is indicated.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.
   2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
   3. Taping, filling and sanding is not required at base layer of double layer applications.

E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

F. Spray apply high build drywall surfacer over entire surface after joints have been properly treated to achieve Level 5 finish in areas indicated.

G. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.08 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Portland cement plaster for installation over metal lath, masonry, concrete, and solid surfaces.

1.02 RELATED REQUIREMENTS
   A. Section 09 22 36.23 - Metal Lath: Metal furring and lathing for plaster.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
   B. Product Data: Provide data on plaster materials, characteristics and limitations of products specified.
   C. LEED Submittals: Complete LEED Project Submittal Form, Section 01 33 00, for the following Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: (Regional) Straight-line distance to Manufacturer and distance to material extraction for each product. If greater than 500 miles, report “> 500”. Product cost data.

1.05 QUALITY ASSURANCE
1.06 MOCK-UP
   A. Construct mock-up of exterior wall, 10 feet long by 10 feet wide, illustrating surface finish.
   B. Locate where directed.
   C. Mock-up may remain as part of the Work.

1.07 FIELD CONDITIONS
   A. Do not apply plaster when substrate or ambient air temperature is under 50 degrees F or over 80 degrees F.
   B. Maintain minimum ambient temperature of 50 degrees F during installation of plaster and until cured.

PART 2 PRODUCTS
2.01 PLASTER MATERIALS
   A. Portland Cement, Aggregates, and Other Materials: In accordance with ASTM C 926.
   B. Premixed Base Coat: BMI type; Natural Base manufactured by BMI Products.
   C. Premixed Finish Coat: BMI type; White Base color selected from manufacturers standard manufactured by BMI Products.

2.02 METAL LATH
   A. Metal Lath and Accessories: As specified in Section 09 22 36.23.
   B. Beads, Screeds, and Joint Accessories: As specified in Section 09 22 36.23.

2.03 ACCESSORIES
   A. Extruded Aluminum Soffit Vent
   B. Extruded Aluminum Channel Screed.

2.04 PLASTER MIXES
   A. Over Metal Lath: Three-coat application, mixed and proportioned in accordance with manufacturer's instructions.
   B. Premixed Plaster Materials: Mix in accordance with manufacturer's instructions.
C. Mix only as much plaster as can be used prior to initial set.
D. Mix materials dry, to uniform color and consistency, before adding water.
E. Protect mixtures from freezing, frost, contamination, and excessive evaporation.
F. Do not retemper mixes after initial set has occurred.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify the suitability of existing conditions before starting work.
B. Metal Lath and Accessories: Verify lath is flat, secured to substrate, and joint and surface perimeter accessories are in place.

3.02 PLASTERING
A. Apply plaster in accordance with ASTM C926.
B. Two-Coat Application:
   1. Apply first coat to nominal thickness of 3/8 inch.
   2. Apply finish coat to nominal thickness of 1/8 inch.
C. Three-Coat Application Over Metal Lath:
   1. Apply first coat to a nominal thickness of 3/8 inch.
   2. Apply second coat to a nominal thickness of 3/8 inch.
   3. Apply finish coat to a nominal thickness of 1/8 inch.
D. Three-Coat Application Over Solid Bases:
   1. Apply first coat to a nominal thickness of 1/4 inch.
   2. Apply second coat to a nominal thickness of 1/4 inch.
   3. Apply finish coat to a nominal thickness of 1/8 inch.
E. In exterior work, scribe contraction joints through entire plaster application at 10 feet on center each way.
F. Moist cure base coats.
G. Apply second coat immediately following initial set of first coat.
H. After curing, dampen previous coat prior to applying finish coat.
I. Finish Texture: Float to a consistent and smooth finish.
J. Avoid excessive working of surface. Delay troweling as long as possible to avoid drawing excess fines to surface.
K. Moist cure finish coat for minimum period of 48 hours.

3.03 TOLERANCES
A. Maximum Variation from True Flatness: 1/8 inch in 10 feet.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Tile for floor applications.
B. Tile for wall applications.
C. Tile for counters.
D. Tile for shower receptors.
E. Tile for stairs.
F. Cementitious backer board as tile substrate.
G. Coated glass mat backer board as tile substrate.
H. Stone thresholds.
I. Ceramic accessories.
J. Ceramic trim.
K. Non-ceramic trim.

1.02 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
D. Samples: Mount tile and apply grout on two plywood panels, minimum 18 x 18 inches in size illustrating pattern, color variations, and grout joint size variations.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
G. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.
H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than _______ of each type.
   3. Extra Tile: 10 square feet of each size, color, and surface finish combination.
I. LEED Submittal: Documentation of recycled content and location of manufacture.
1.04 QUALITY ASSURANCE
A. Maintain one copy of TCNA Handbook and ANSI A108 Series/A118 Series on site.
B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum 5 years of documented experience.
C. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.

1.05 MOCK-UP
A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
B. Construct tile mock-up where indicated on the drawings, incorporating all components specified for the location.
   1. Minimum size of mock-up is indicated on the drawings.
   2. Approved mock-up may remain as part of the Work.
   3. Demolish mock-up when directed by Architect, and remove debris from the site.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.07 FIELD CONDITIONS
A. Do not install solvent-based products in an unventilated environment.
B. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

PART 2 PRODUCTS
2.01 TILE
A. Manufacturers: All products by the same manufacturer.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Ceramic Mosaic Tile: ANSI A137.1, and as follows:
   1. __________ manufactured by __________ or approved equivalent product.
   2. Moisture Absorption: 0 to 0.5 percent.
   3. Size and Shape: 1 inch square.
   4. Edges: Square.
   6. Colors: As shown on drawings.
   7. Colors: To be selected by Architect from manufacturer's standard range.
   8. Mounted Sheet Size: _____ x _____ inches.
   9. Trim Units: Matching bead, cove, and surface bullnose shapes in sizes coordinated with field tile.
C. Glazed Wall Tile: ANSI A137.1, and as follows:
   1. __________ manufactured by __________ or approved equivalent product.
   2. Moisture Absorption: 3.0 to 7.0 percent.
   3. Size and Shape: 4-1/4 inch square.
   4. Edges: Cushioned.
   6. Colors: To be selected by Architect from manufacturer's standard range.
   7. Colors: As scheduled.
   8. Pattern: __________.
   9. Trim Units: Matching bead, bullnose, cove, and base shapes in sizes coordinated with field tile.
D. Quarry Tile: ANSI A137.1, and as follows:
1. Manufacturers: All products by the same manufacturer.
   c. Metropolitan Ceramics: www.metroceramics.com
   e. _______.
   f. Substitutions: See Section 01 60 00 - Product Requirements.
2. Moisture Absorption: 0.5 to 3.0 percent.
3. Size and Shape: 8 inch square.
5. Edges: Square.
7. Colors: To be selected by Architect from manufacturer's standard range.
8. Colors: As scheduled.
9. Pattern: _________.
10. Trim Units: Matching bullnose, cove, cove base, and window sill or step nosing shapes in sizes coordinated with field tile.

E. Paver Tile: ANSI A137.1, and as follows:
   1. ________ manufactured by __________ or approved equivalent product.
   2. Moisture Absorption: 0 to 0.5 percent.
   3. Size and Shape: 6 inch square.
   4. Thickness: 3/8 inch
   5. Face: Plain.
   7. Colors: To be selected by Architect from manufacturer's standard range.
   8. Colors: As scheduled.
   9. Trim Units: Matching bullnose, double bullnose, cove base, cove, and window sill or step nosing shapes in sizes coordinated with field tile.

2.02 TRIM AND ACCESSORIES

A. Ceramic Accessories: Glazed finish, same color and finish as adjacent field tile; same manufacturer as tile.
   1. Soap Dish: With handle, clam shell design, recess mounted; cast strength sufficient to resist lateral pull force of 75 lbs.
   2. Toilet Tissue Holder: Recessed, for single roll, with spring loaded holder.
   3. Towel Bars: Standard design, surface mounted with extensions for casting into small wall openings; cast strength sufficient to resist lateral pull force of 30 lbs.

B. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
   1. Applications: Use in the following locations:
      a. Open Edges: Bullnose.
      b. Inside Corners: Jointed.
      c. Floor to Wall Joints: Cove base.
   2. Manufacturer: Same as for tile.

C. Non-Ceramic Trim: Satin brass anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
   1. Applications: Use in the following locations:
      a. Open edges of wall tile.
      b. Open edges of floor tile.
      c. Wall corners, outside and inside.
      d. Transition between floor finishes of different heights.
      e. Thresholds at door openings.
      f. Expansion and control joints, floor and wall.
      g. Floor to wall joints.
h. Borders and other trim as indicated on drawings.
i. Balcony and terrace edge trim and fascia.

2. Manufacturer:
c. Substitutions: See Section 01 60 00 - Product Requirements.

D. Thresholds: Marble, white or gray, honed finish; 2 inches wide by full width of wall or frame opening; 1/2 inch thick; beveled one long edge with radiused corners on top side; without holes, cracks, or open seams.
1. Applications: Provide at the following locations:
a. At doorways where tile terminates.
b. At open edges of floor tile where adjacent finish is a different height.

2.03 SETTING MATERIALS

2.04 ADHESIVE MATERIALS

A. Manufacturers:
1. Bonsal American, Inc; StayFlex 590: www.prospec.com

B. Organic Adhesive: ANSI A136.1, thinset bond type; use Type I in areas subject to prolonged moisture exposure.


D. Tile Setting Adhesive: Elastomeric, waterproof, liquid applied, ________.

2.05 MORTAR MATERIALS

A. Manufacturers:
1. Bonsal American, Inc; Permalastic System: www.prospec.com


C. Mortar Bond Coat Materials for Thin-Set Installations:
2. Latex-Portland Cement type: ANSI A118.4.
3. Epoxy: ANSI A118.3.
4. Furan: ANSI A118.5.
5. For Exterior Glue Plywood: ANSI A118.11.
6. Conductive Type: ________.

2.06 GROUTS

A. Manufacturers:
1. Bonsal American, Inc; ProSpec Sanded Tile Grout 700: www.prospec.com
4. _____: Product _____.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Standard Grout: Any type specified in ANSI A118.6 or A118.7.
1. Colors: To be selected by Architect from manufacturer's standard range.
2. Colors: As scheduled.

C. Furan Grout: ANSI A118.5, furan resin type, ________ color as selected; use for ________ applications.
1. Color: ________: as selected by Architect from manufacturer's standard line.
2. Color: ________: as shown on the drawings.
D. Silicone Rubber Grout: Silicone sealant, moisture and mildew resistant type, ________ color as selected; use for ________.
   1. Color: ________; as selected by Architect from manufacturer's standard line.
   2. Color: ________; as shown on the drawings.

2.07 THICK-BED MATERIALS

2.08 THIN-SET ACCESSORY MATERIALS

A. Cleavage Membrane: No. 15 asphalt saturated felt.
B. Cleavage Membrane: 4 mil thick polyethylene film.
C. Cleavage Membrane: Reinforced asphalt paper.
D. Uncoupling Membrane: 1/8 inch thick polyurethane matting with three-dimensional grid structure with dovetail shaped cavities and fleece webbing laminated to the underside to provide a mechanical bond to the substrate adhesive (DITRA).
   1. Acceptable Product: Schluter Systems "DITRA."
E. Waterproofing Membrane at Floors: As specified in Section 07 12 00.
F. Waterproofing Membrane at Floors: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
   1. Type: Fluid-applied.
   5. Products:
      c. COMPOTITE Corporation; Composeal Gold: www.compotite.com.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
G. Waterproofing Membrane at Showers and Tiled Tubs: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
   1. Type: Fluid-applied.
   5. Products:
      c. COMPOTITE Corporation; Composeal 40 mil Blue: www.compotite.com.
      e. ________; ________.
      f. Substitutions: See Section 01 60 00 - Product Requirements.
H. Membrane at Walls: No. 15 asphalt saturated felt.
I. Membrane at Walls: 4 mil thick polyethylene film.
J. Membrane at Walls: Reinforced asphalt paper.
K. Reinforcing Mesh: 2 x 2 inch size weave of 16/16 wire size; welded fabric, galvanized.
L. Metal Lath: ASTM C 847, Flat diamond mesh, of weight to suit application, galvanized finish.

M. Cementitious Backer Board: ANSI A118.9; High density, cementitious, glass fiber reinforced, 1/2 inch thick; 2 inch wide coated glass fiber tape for joints and corners.
   1. Product: __________ manufactured by __________.

N. Coated Glass Mat Backer Board: ASTM C1178/C1178M, with coated inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder.
   1. Product: __________ manufactured by __________.
   2. Standard Type: Thickness 1/2 inch.
   3. Fire-Resistant Type: Type X core, thickness 5/8 inch.

O. Mesh Tape: 2-inch wide self-adhesive fiberglass mesh tape.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.

D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.

E. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
   1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.

F. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Protect surrounding work from damage.

B. Vacuum clean surfaces and damp clean.

C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.

E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1 through A108.13, manufacturer's instructions, and TCNA Handbook recommendations.

B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.

C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.

D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.

E. Form internal angles square and external angles bullnosed.

F. Install ceramic accessories rigidly in prepared openings.
G. Install non-ceramic trim in accordance with manufacturer's instructions.
H. Install thresholds where indicated.
I. Sound tile after setting. Replace hollow sounding units.
J. Keep expansion joints free of adhesive or grout. Apply sealant to joints.
K. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
L. Grout tile joints. Use standard grout unless otherwise indicated.
M. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS
A. Over exterior concrete substrates, install in accordance with TCNA Handbook Method F102, with standard grout.
B. Over interior concrete substrates, install in accordance with The Tile Council of North America Handbook Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
C. Over interior concrete substrates, install in accordance with TCNA Handbook Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
1. Where waterproofing membrane is indicated, install in accordance with The Tile Council of North America Handbook Method F122, with latex-Portland cement grout.
2. Where waterproofing membrane is indicated, install in accordance with TCNA Handbook Method F122, with latex-portland cement grout.
3. Where epoxy bond coat and grout are indicated, install in accordance with TCNA Handbook Method F131.
4. Where furan bond coat and grout are indicated, install in accordance with TCNA Handbook Method F133.
5. Where epoxy or furan grout is indicated, but not epoxy or furan bond coat, install in accordance with TCNA Handbook Method F115.
D. Over wood substrates, install in accordance with TCNA Handbook Method F142, with standard grout, unless otherwise indicated.
1. Where epoxy bond coat and grout are indicated, install in accordance with TCNA Handbook Method F143.
E. Over wood substrate with backer board underlayment, install in accordance with TCNA Handbook Method F144, for cementitious backer boards, with standard grout.

3.05 INSTALLATION - FLOORS - MORTAR BED METHODS
A. Over exterior concrete substrates, install in accordance with TCNA F101, bonded, with standard grout.
B. Over interior concrete substrates, install in accordance with TCNA Handbook Method F111, with cleavage membrane, unless otherwise indicated.
1. Where waterproofing membrane is indicated, with standard grout or no mention of grout type, install in accordance with TCNA Handbook Method F121.
2. Where epoxy bond coat and grout are indicated, install in accordance with TCNA Handbook Method F132, bonded.
3. Where epoxy or furan grout is indicated, but not epoxy or furan bond coat, install in accordance with TCNA Handbook Method F114, with cleavage membrane.
C. Over wood substrates, install in accordance with TCNA Handbook method F141, with standard grout, unless otherwise indicated.
D. Cleavage Membrane: Lap edges and ends.
E. Mortar Bed Thickness: 5/8 inch, unless otherwise indicated.

3.06 INSTALLATION - SHOWERS AND BATHTUB WALLS
A. At tiled shower receptors install in accordance with TCNA Handbook Method B415, mortar bed floor, and W244, thin-set over cementitious backer unit walls.
B. At bathtub walls install in accordance with TCNA Handbook Method B412, over cementitious backer units with waterproofing membrane.

C. Grout with standard grout as specified above.

D. Grout with standard grout as specified above.

E. Seal joints between tile work and other work with sealant Type ____ specified in Section 07 90 05.

3.07 INSTALLATION - WALL TILE

A. On exterior walls install in accordance with TCNA Handbook Method W244, thin-set over cementitious backer units, with waterproofing membrane.

B. Over cementitious backer units on studs, install in accordance with TCNA Handbook Method W244, using membrane at toilet rooms.

C. Over cementitious backer units install in accordance with TCNA Handbook Method W223, organic adhesive.

D. Over coated glass mat backer board on studs, install in accordance with TCNA Handbook Method W245.

E. Over gypsum wallboard on wood or metal studs install in accordance with TCNA Handbook Method W243, thin-set with dry-set or latex-portland cement bond coat, unless otherwise indicated.
   1. Where mortar bed is indicated, install in accordance with TCNA Handbook Method W222, one coat method.
   2. Where waterproofing membrane is indicated other than at showers and bathtub walls, install in accordance with TCNA Handbook Method W222, one coat method.

F. Over interior concrete and masonry install in accordance with TCNA Handbook Method W202, thin-set with dry-set or latex-portland cement bond coat.

G. Over wood studs without backer install in accordance with TCNA Handbook Method W231, mortar bed, with membrane where indicated.

H. Over metal studs without backer install in accordance with TCNA Handbook Method W241, mortar bed, with membrane where indicated.

3.08 CLEANING

A. Clean tile and grout surfaces.

3.09 PROTECTION

A. Do not permit traffic over finished floor surface for 4 days after installation.

3.10 TILE SCHEDULE

A. CT-1
   1. Location: Fountain Court/Fishbowl Floors
   2. Manufacturer: Pental Granite and Marble
   3. Style: Stone Box
   4. Color: Black Ink
   5. Size: 6 inch by 36 inch
   6. Installed: 1/3 running bond

B. CT-2
   1. Location: Restroom Floors
   2. Manufacturer: American Olean
   3. Style: Unglazed Ceramic Mosaics, Hexagon Field Tile
   4. Color: Black A34
   5. Size: 1 inch hexagon

C. CT-3
   1. Location: Restroom Wall Field Tile
2. Manufacturer: Stone Source
3. Style: Unon Unon
4. Color: All White - Matte Porcelain
5. Size: 8 inch by 48 inch
6. Installed: Horizontal, 1/3 running bond

D. CT-4
1. Location: Restroom Wall Accent Tile
2. Manufacturer: Stone Source
3. Style: Unon Unon
4. Color: White on White Negative - Matte Porcelain
5. Installed: Horizontal, 1/3 running bond

E. CT-5
1. Location: Washroom Wall Tile
2. Manufacturer: American Olean
3. Style: Bright Glazed Ceramic Tile
4. Color: Ice White 0025
5. Size: 4 inch by 4 inch
6. Installed: Stack Bond

F. CT-6
1. Location: O Lounge Restroom Wall Accent Tile
2. Manufacturer: Stone Source
3. Style: Unon Unon
4. Color: Nero White Negative
5. Size: 8 inch by 48 inch
6. Installed: Horizontal, 1/3 running bond

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.
B. Acoustical units.
C. Supplementary acoustical insulation above ceiling.

1.02 PERFORMANCE REQUIREMENTS

A. Submit design data in compliance with Section 01 33 16 when required by AHJ.
B. Seismic Design Requirements: Provide ceilings designed and installed to withstand the effects of earthquake motions according to the following:
   1. IBC Seismic Design Category for Project Site: D, E, or F, severe.
   2. Alternate methods approved by authority having jurisdiction (AHJ).
   3. Edge Molding Design: Face of molding less than 1 inch wide and concealed clip.
   4. Provide rigidly braced system.
C. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
   1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
      b. Identify materials with appropriate markings of applicable testing and inspecting agency.
   2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
      a. Smoke-Developed Index: 450 or less.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate grid layout and related dimensioning.
C. Product Data: Provide data on suspension system components.
D. Samples: Submit two full size samples illustrating material and finish of acoustical units.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   4. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
F. Manufacturer's Installation Instructions: Indicate special procedures.

1.04 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.
1.05 PROJECT CONDITIONS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Install acoustical units after interior wet work is dry.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Acoustical Units - General: comply with ASTM E 1264, Class A.
   1. Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

C. Acoustical Panels Type ____:
   1. Size: 24 x 48 inches.
   2. Thickness: 3/4 inches.
   3. Composition: Wet felted.
   4. Light Reflectance: ____ percent, determined as specified in ASTM E1264.
   5. NRC Range: ____ to ____., determined as specified in ASTM E1264.
   7. Ceiling Attenuation Class (CAC): ____., determined as specified in ASTM E1264.
   8. Edge: Reveal edge.
   10. Product: ____ by ________.
   11. Suspension System: Exposed grid Type ____.

D. Aluminum Acoustic Baffle Ceiling: TBD

E. Cementitious Wood Fiber Ceiling: TBD

2.02 SUSPENSION SYSTEM(S)

A. Suspension Systems - General: ASTM C 635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.

B. Exposed Steel Suspension System Type ACT-1: Formed steel, commercial quality cold rolled; heavy-duty.
   1. Profile: Tee; 15/16 inch wide face.
   2. Construction: Double web.
   4. Product: ____ by ________.

2.03 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Perimeter Moldings: Same material and finish as grid.
   1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
   2. L-Shaped Molding: Less than 1 inch wide exposed face. Provide concealed seismic clip approved by AHJ.
C. Acoustical Insulation: Specified in Section 07 21 00.
   1. Thickness: 6 inch.
   2. Size: To fit acoustical suspension system.
D. Acoustical Sealant For Perimeter Moldings: Specified in Section 07 90 05.
E. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.
F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM
A. Install suspension system in accordance with ASTM C 636, ASTM E 580, and manufacturer's instructions and as supplemented in this section.
B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
C. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
D. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
G. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
H. Do not eccentrically load system or induce rotation of runners.
I. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.
   2. Overlap and rivet corners.

3.03 INSTALLATION - ACOUSTICAL UNITS
A. Install acoustical units in accordance with manufacturer's instructions.
B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
C. Fit border trim neatly against abutting surfaces.
D. Install units after above-ceiling work is complete.
E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
F. Cutting Acoustical Units:
   1. Cut to fit irregular grid and perimeter edge trim.
   2. Make field cut edges of same profile as factory edges.
   3. Finish cuts to match factory finish.
   4. Double cut and field paint exposed reveal edges.
G. Where round obstructions occur, provide preformed closures to match perimeter molding.

3.04 TOLERANCES
A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.
A. ACT-1 (Accessible)
   1. Location: Acoustic Ceiling at Offices
   2. Manufacturer: Armstrong
   3. Style: Ultima Mineral Fiber High-NRC Beveled Tegular 1942 HRC
   4. Size: 24 inch by 24 inch
   5. Suspension System: 9/16 inch Interlude XL Suspension System
   6. Color: Blizzard White Finish

B. ACT-2 (Accessible)
   1. Location: Plank acoustic ceiling at conference rooms/Hearth
   2. Manufacturer: Armstrong
   3. Style: Techzone 3262PB, Optima Square Tegular, with plant based binder with 6 inch
tech panels
   4. Size: 24 inch by 96 inch
   5. Suspension System: 9/16 inch Interlude XL Suspension System
   6. Color: Blizzard White Finish

C. ACT-3 (No access)
   1. Location: Acoustic ceiling at Student Street
   2. Manufacturer: Armstrong
   3. Style: Optima Vector #3907
   4. Size: 24 inch by 96 inch
   5. Suspension System: Fully concealed grid - 1/4 inch reveal with 15/16 inch vector Prelude
   suspension system or Decoustics Claro-T New Generation direct mount
   6. Color: Blizzard White Finish

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Linear wood ceiling system and suspension system.
B. Suspension systems (Delegated Design).
C. Accessories: Accessories and other necessary items including attachment devices overhead construction, secondary members, splines, splices, connecting clips, wall connectors, wall angles, and other devices required for a complete installation.
   1. Supplemental support framing: Provide fully engineered secondary framing as required to meet code, conforming to layout shown in drawings, to support direct-hung metal ceilings suspension system.
   2. Coordinate layout and installation of items penetrating or being installed in ceiling systems with responsible trades.

1.02 DEFINITIONS

A. AC: Articulation Class, per ASTM E 1264
B. NRC: Noise Reduction Coefficient, per ASTM E 1264 or per ASTM C 423 for mounting type specified
   1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.

1.03 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures.
B. Product Data: For each type of product indicated.
C. Coordinate Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items, in PDF format. Show the following:
   1. Ceiling suspension members.
   2. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED credits. Requirements and definitions are located in Section 01 35 15 and section 01 60 00. Submit in PDF format:
   1. Credit MR 4: Recycled content for each product, post-consumer and post-industrial; Product cost data
   2. Credit MR 5: List Products that are extracted, harvested or recovered as well as manufactured within 500 straight line miles of Project Site, or percentage of regional material by weight. Include address and distance of material source and product manufacture; product cost data.
   3. Credit MR 7: Chain of custody documentation for products containing FSC certified wood; New wood cost data.
   4. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   5. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
   6. Credit EQc 4.4: Manufacturers' product data for no added urea-formaldehyde composite wood and agrifiber wood products.
E. Field quality-control test reports, in PDF format.
F. Maintenance Data: For finishes to include in maintenance manuals, in PDF format.

1.04 QUALITY ASSURANCE

A. Source Limitations:
   1. Suspension System: Obtain each type through one source from a single manufacturer.
B. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
   1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      b. Identify materials with appropriate markings of applicable testing and inspecting agency.
   2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
      a. Smoke-Developed Index: 450 or less.

C. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
   1. IBC Standard, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."

D. Mockup: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.
   1. Size: not less than 150 square feet, corner location approved by Contracting Officer.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver wood strip panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
B. Before installing wood strip panels, permit them to reach room temperature and a stabilized moisture content for a minimum of 72 hours prior to installation.
C. Handle wood strip panels carefully to avoid denting or abrading edges or damaging panels in any way.

1.06 PROJECT CONDITIONS
A. Environmental Limitations: Do not install wood strip panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.07 COORDINATION
A. Coordinate layout and installation of wood strip panels and suspension system 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
2.01 MANUFACTURERS
A. Basis of Design:
   1. 9 Wood; www.9wood.com
B. Acceptable manufacturers pending conformance to basis of design requirements:
   1. Architectural Surfaces, Inc; www.architecturalsurfaces.net
   2. Armstrong; www.armstrong.com
4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
   1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.
   1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.

E. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

F. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure wood strip panels in-place.

G. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.

2.03 LINEAR WOOD STRIP PANEL CEILING

A. System Performance:
   1. NRC: 0.80

B. Suspension System: Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished 24 mm (15/16-inch)- wide metal caps on flanges.
   1. Structural Classification: Heavy-duty system.
   2. End Condition of Cross Runners: Override (stepped) type.
   3. Face Design: Flat, flush.
   5. Cap Finish: Painted black

C. Wood: FSC Certified, solid Hemlock.

D. Wood Strip Panels: Prefinished, custom clip mounted to suspension system:
   1. Wood Strip WDC-1 and WDC-2: nominal 19 x 133 mm (3/4 by 5-1/4 inches) or dimensions as indicated on drawings, solid wood strips, manufactured within 500 miles of project site.
   2. Slat Spacing:
      a. WDC-1: 171mm (6 ¾ inches) or as indicated on drawings.
      b. WDC-2: 152mm (6 inches) or as indicated on drawings.
   3. Edge and End Details: Butt ends, space at perimeter as indicated on drawings. Provide square edge profile. Provide matching hardwood edgebanding at side profile. At exposed ends, provide solid oak end cap, as indicated on drawings.
4. Black scrim installed between the wood slats and the suspension system

E. Wood Finish: Manufacturer's clear finish; stain to match architect's sample.

2.04 ACCESSORIES

A. Wood Strip Retension/Spacer Clip: Provide custom fabricated retension/spacer clips to retain wood strips in consistent alignment and spacing of 38 mm (1-1/2 inch) and provide demountable connection for each wood strip.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which linear wood ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Measure each ceiling area and establish layout of linear wood ceiling to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.03 INSTALLATION

A. Install panel ceilings to comply with IBC Standard and seismic requirements indicated, per manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post installed mechanical, or power-actuated fasteners that extend through forms into concrete.

6. Do not attach hangers to steel deck tabs.

7. Do not attach hangers to steel roof deck. Attach hangers to structural members.

8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post installed anchors.

D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install panels in compliance with Manufacturer's instructions using clips to suspension system. Layout panels per approved Shop Drawing.
F. Install acoustical board on upper surface of panels and fasten in place. Assure no labels or graphic is visible.

3.04 CLEANING

A. Clean exposed surfaces of linear wood ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.05 WOOD CEILING SCHEDULE

A. ACOUSTIC LINEAR WOOD CEILING - 1:
   1. Location: The Duck Nest
   2. System: Nine Wood 2100 Series Linear Wood Ceiling - T grid suspension, 1/2" x 1 1/4" cross pieces, painted black. 5/8" x 5 1/4" veneer on NAUF MDF, black acoustic backer
   http://9wood.com/styles/index/2100

B. LINEAR WOOD CEILING - 2:
   1. Location: The O Lounge
   2. System: (Site Built) 1/2" x 5 1/4" veneer on NAUF MDF planks mounted on gypsum board mounted to ceiling grid. Extruded aluminum perimeter trim (radiused). Option to use reclaimed wood.

C. WOOD GRILLE CEILING - 3:
   1. Location: Entry Vestibules
   2. System: (Site Built) Reclaimed solid softwood grille ceiling, panelized. Cross members 3/4" x 1 1/2" black painted soft wood, reclaimed wood grille members, 5 1/4" oc, 1 1/2" x 5 1/2", black acoustic panel mounted between grille and cross member

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Wood strip flooring, nailed.

1.02 RELATED SECTIONS
   A. Section 03 30 00 - Cast-in-Place Concrete: Recessed concrete subfloor surface and formed depressions for deep floor sockets.
   B. Section 09 90 00 - Painting and Coating: Surface finish to flooring.
   C. Section 12 66 13 - Telescoping Bleachers
   D. Section 13 48 00 - Sound Vibration Seismic Control
   E. Divisions 26 & 27 for Floor Boxes

1.03 REFERENCE STANDARDS
   A. MFMA (SPEC) - Guide Specifications for Maple Flooring Systems; Maple Flooring Manufacturers Association; current edition.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data for flooring.
   C. Shop Drawings: Indicate floor joint pattern and termination details.
      1. Indicate provisions for expansion and contraction.
   D. Samples: Submit two samples 6 x 12 inch, one finished and one unfinished.
   E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      1. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      2. Credit MR 7: Chain of custody documentation for products containing FSC certified wood. New wood cost data.
      3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
      4. Credit EQ 4.2: Manufacturers’ product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.
   F. Installation Instructions: Indicate standard and special installation procedures.
   G. Maintenance Data: Include maintenance procedures.

1.05 QUALITY ASSURANCE
   A. Perform work of this section in accordance with MFMA (SPEC).
   B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   C. Installer Qualifications: Company specializing in performing work of this section with minimum five years experience.

1.06 FIELD CONDITIONS
   A. Do not install wood flooring until wet construction work is complete and ambient air at installation space has moisture content stabilized at maximum moisture content of 40 percent.
   B. Provide heat, light, and ventilation prior to installation.
   C. Store materials in area of installation for minimum period of 72 hours prior to installation for wood to acclimate to relative humidity.
D. Maintain minimum room temperature of 65 degrees F for a period of two days prior to delivery of materials to installation space, during installation, and after installation.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Wood Strip Flooring: See schedule below.
   B. Flooring Nails: Type recommended by flooring manufacturer.
   C. Building Paper
   D. Plywood Subfloor: 23 inch/32 inch thick plywood; APA rated sheathing, tongue and groove edges, exp. 1; sanded.
   E. Solid wood blocking; pressure treated.

2.02 ACCESSORIES
   A. Transition Strip: Same species and finish as flooring material; profiles indicated.

2.03 SOURCE QUALITY CONTROL
   A. Inspect and stamp species and grade on underside of each piece of wood flooring at factory.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify concrete subfloor and wood finish floor smooth and flat to +/- 1/8 inch in 8 foot 0 inch.
   C. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION
   A. Prepare substrate to receive wood flooring in accordance with manufacturer's, NOFMA, and NWFA instructions.
   B. Broom clean substrate.
   C. Coordinate solid wood blocking with telescoping seating wheel locations.

3.03 INSTALLATION
   A. Sheathing Paper: Place over wood subfloor; lap edges and ends 2 inches, staple in place.
   B. Plywood subfloor: place over building paper.
   C. Building paper: place over plywood subfloor.
   D. Wood Flooring:
      1. Install in accordance with manufacturer's, MFMA, and NWFA instructions; predrill and blind nail to sleepers.
      2. Lay flooring parallel to length of room areas. Verify alignment as work progresses.
      3. Arrange flooring with end matched grain set flush and tight.
      4. Terminate flooring at centerline of door openings where adjacent floor finish is dissimilar; provide divider strips and transition strips in accordance with flooring manufacturer's recommendations and as indicated.
      5. Install edge strips at unprotected or exposed edges, and where flooring terminates.
      7. Install flooring tight to floor access covers.
      8. Provide 1/4 inch expansion space at fixed walls and other interruptions.
   E. Finishing:
      1. Mask off adjacent surfaces before beginning sanding.
      2. Sand flooring to smooth even finish with no evidence of sander marks. Take precautions to contain dust. Remove dust by vacuum.
      3. Apply finish in accordance with floor finish manufacturer's instructions.
4. Apply first coat, allow to dry, then buff lightly with steel wool to remove irregularities. Vacuum clean and wipe with damp cloth before applying succeeding coat.
5. Lightly buff between coats with steel wool and vacuum clean before applying succeeding coat.
6. Apply last coat of finish.

3.04 CLEANING
A. Clean and polish floor surfaces in accordance with manufacturer's instructions.

3.05 PROTECTION
A. Prohibit traffic on floor finish for 48 hours after installation.
B. Place protective coverings over finished floors; do not remove coverings until Substantial Completion.

3.06 SCHEDULES
A. WD-1
   1. Manufacturer: Sustainable Northwest Wood
   2. Species: Oregon white oak
   3. Grade: Select and better
   4. Cut: Edge grain
   5. Moisture content: 7 to 9 percent
   6. Actual Thickness: 3/4 inch
   7. Edge: Tongue and groove
   8. End: End matched
   9. Length: Random, minimum of 24 inches
  10. Finish: Clear, matte stain, field applied.
  11. Notes: Acoustic underlayment

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Resilient sheet flooring.
   B. Resilient base.
   C. Installation accessories.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
   C. Shop Drawings: Indicate seaming plan.
   D. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
   E. Verification Samples: Submit two samples, 12 by 12 inch in size illustrating color and pattern for each resilient flooring product specified.
   F. Concrete Testing Standard: Submit a copy of ASTM F710.
   G. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
   H. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      3. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
   I. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
   J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.03 DELIVERY, STORAGE, AND HANDLING
   A. Protect roll materials from damage by storing on end.

1.04 FIELD CONDITIONS
   A. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
   B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 SHEET FLOORING
   A. Rubber Sheet Flooring: 100 percent rubber composition, color and pattern through total thickness:
      1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
      2. VOC Content: As specified in Section 01 61 16.
      3. VOC Content: Certified as Low Emission by one of the following:
RESILIENT FLOORING

4. Total Thickness: 0.125 inch minimum.
5. Sheet Width: 36 inch minimum.
6. Design: Flat.
8. Manufacturers:
   b. Expanko Resilient Flooring: www.expanko.com
   c. PRF USA, Inc: www.rubberfloors.com
   d. Johnsonite, a Tarkett Company: www.johnsonite.com
   e. Mondo: www.mondoworldwide.com
   f. Substitutions: See Section 01 60 00 - Product Requirements.

B. Linoleum Sheet Flooring: Homogeneous wear layer bonded to backing, with color and pattern through wear layer thickness:
   1. Minimum Requirements: Comply with ASTM F2034, Type corresponding to type specified.
   2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
   3. VOC Content: As specified in Section 01 61 16.
   4. VOC Content: Certified as Low Emission by one of the following:
   6. Wear Layer Thickness: 0.098 inch, minimum, excluding backing.
   7. Sheet Width: 79 inch, minimum.
   9. Color: As shown on drawings.
10. Color: To be selected by Architect from manufacturer's full range.
12. Manufacturers:
    d. ____; Product ____.
    e. Substitutions: See Section 01 60 00 - Product Requirements.

C. Feature Strips: Of same material as sheet flooring, ____ inch wide.

D. Linoleum Welding Rod: Solid color linoleum produced by flooring manufacturer for heat welding seams, in color in color matching predominant flooring color.

2.02 RESILIENT BASE

A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove, and as follows:
   1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
   2. Height: 4 inch.
   3. Thickness: 0.125 inch thick.
   5. Length: 4 foot sections.
   7. Color: Color as selected from manufacturer's standards.
   8. Accessories: Premolded external corners and end stops.
   9. Manufacturers:
RESILIENT FLOORING

d. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 ACOUSTIC UNDERLAYMENT

A. Acoustic Underlayment:
   1. Jumpax - www.jumpax.net
   2. VC300 - www.vc300.com
   3. Impacta Regupol 3mm - www.rubberunderlayment.com

2.04 ACCESSORIES

A. Subfloor Filler: Modified Portland cement type recommended by adhesive material manufacturer.
B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
   1. Provide only products having lower volatile organic compound (VOC) content than required by the more stringent of the South Coast Air Quality Management District Rule No.1168 and the Bay Area Air Quality Management District Regulation 8, Rule 51.
   2. VOC Content: Comply with requirements in Section 01 60 00.
C. Moldings, Transition and Edge Strips: Same material as flooring.
D. Sealer and Wax: Types recommended by flooring manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
   1. Specified required experience makes it incumbent upon flooring installer as ultimate source of product compatibility to notify the Contractor of potential incompatibility issues with adhesive and substrate prior to installation.
B. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive resilient flooring.
C. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
D. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
E. Verify that concrete sub-floor surfaces are dry enough and ready for resilient flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F710; obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
F. Verify that concrete sub-floor surfaces are ready for resilient flooring installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
   1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.
G. Verify that required floor-mounted utilities are in correct location.
3.02 PREPARATION
   A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI Recommended Work Practices for Removal of Resilient Floor Coverings.
   B. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
   C. Prohibit traffic until filler is cured.
   D. Clean substrate.
   E. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION
   A. Starting installation constitutes acceptance of sub-floor conditions.
   B. Install in accordance with manufacturer's instructions. Apply flooring with manufacturer approved adhesives for appropriate and correctly prepared substrates.
   C. Spread only enough adhesive to permit installation of materials before initial set.
   D. Fit joints tightly.
   E. Set flooring in place, press with heavy roller to attain full adhesion.
   F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
   G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
      1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.
      2. Resilient Strips: Attach to substrate using adhesive.
   H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
   I. Install flooring in recessed floor access covers, maintaining floor pattern.
   J. At movable partitions, install flooring under partitions without interrupting floor pattern.

3.04 SHEET FLOORING
   A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns carefully at seams.
   B. Seams are prohibited in bathrooms, kitchens, toilet rooms, and custodial closets.
   C. Double cut sheet at seams.
   D. Lay flooring with tightly butted seams, without any seam sealer unless otherwise indicated.
   E. Finish seams in linoleum by heat welding.
   F. Double cut sheet; provide heat welded seams.

3.05 RESILIENT BASE
   A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
   B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
   C. Install base on solid backing. Bond tightly to wall and floor surfaces.
   D. Scribe and fit to door frames and other interruptions.

3.06 CLEANING
   A. Remove excess adhesive from floor, base, and wall surfaces without damage.
   B. Clean in accordance with manufacturer's instructions.
C. Clean, seal, and wax resilient flooring products in accordance with manufacturer's instructions.

3.07 PROTECTION
A. Prohibit traffic on resilient flooring for 48 hours after installation.

3.08 SCHEDULE
A. RF-1
1. Location: Craft Center Dark Room
2. Manufacturer: Nora
3. Style: Sentica, Article 1700
4. Color: 6522 Expedition
5. Thickness: 2.0mm
6. Size: 48" roll
7. Notes: Heat-welded seams

B. RF-2
1. Location: New Elevators
2. Manufacturer: Expanko
3. Style: Cork Rubber Flooring
4. Color: Black
5. Thickness: 2.5mm
6. Size: 24 inch by 24 inch tile

C. LINO-1
1. Location: New back of house stair sections
2. Manufacturer: Forbo
3. Style: TBD
4. Color: TBD
5. Thickness: 2.5mm
6. Size: 48 inch roll
7. Notes: Heat-welded seams

D. RB-1
1. Location: Craft Center
2. Size: 3.5 inch rubber base

E. RB-2
1. Location: North Wing and Existing Building
2. Size: 2.5 inch rubber base

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Plastic matrix terrazzo floor, border and base.
   B. Stairs, landings, and stringers.
   C. Divider strips and recessed mat frames.

1.02 RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B. Section 03 30 00 - Cast-in-Place Concrete: Concrete subfloor with wood float finish.
   C. Section 05 51 00 - Metal Stairs: Formed steel stair pans.
   D. Section 07 95 13 - Expansion Joint Cover Assemblies: Building expansion joint covers.
   E. Section 06 10 00 - Rough Carpentry: Wood subfloor.
   F. Section 07 90 05 - Joint Sealers: Joint between terrazzo base and wall surface.
   G. Section 09 66 13 - Portland Cement Terrazzo Flooring.
   H. Section 09 67 00 - Fluid-Applied Flooring.
   I. Section _____ - ____________: Precast terrazzo.
   J. Section 12 48 13 - Entrance Floor Mats and Frames: Product requirements for recessed floor mat frames installed under this section.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data for divider strips, control joint strips, expansion joints, and sealer; include printed copy of current NTMA recommendations for type of terrazzo involved.
   C. Shop Drawings: Indicate divider strip and control joint layout, and details of adjacent components.
   D. Samples: Submit two samples, ____ x ____ inch in size illustrating color, chip size and variation, chip gradation, matrix color and typical divider strip.
   E. Cleaning and Maintenance Data: Include procedures for stain removal, stripping, and sealing.
   F. LEED Submittal: Documentation of recycled content and location of manufacture.

1.05 QUALITY ASSURANCE
   A. Perform work in accordance with NTMA recommendations as posted at their web site at www.ntma.com.
   B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum _____ years of documented experience.

1.06 MOCK-UP
   A. Construct mock-up of terrazzo flooring, border and base illustrating appearance of finished work at corner. Size mock-up to be not less than 3 x 3 feet.
   B. Locate where directed.
   C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Store resin materials in a dry, secure area.
   B. Maintain minimum temperature of 55 degrees F.
1.08 FIELD CONDITIONS
A. Do not install terrazzo when temperature is below 50 degrees F or above 90 degrees F.
B. Maintain temperature within specified range 24 hours before, during, and 72 hours after installation of flooring.
C. Provide ambient lighting level of 50 ft candles, measured at floor surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Resinous Matrix Terrazzo:
   1. Sherwin-Williams Company: General Polymers Brand; Product ____:
   4. _______; Product ____.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PLASTIC MATRIX TERRAZZO
A. Floors: Epoxy matrix, NTMA Plate No. _____, 1/4 inch thick.
B. Floors: Epoxy matrix, 1/4 inch thick.
   1. Matrix Color: As selected.
   2. Aggregate Color: As selected.
   3. Aggregate Size: No. 0-1.
C. Borders: Same type and thickness as floors, NTMA Plate No. _____.
D. Borders: Same type and thickness as floors.
   1. Matrix Color: As selected.
   2. Aggregate Color: As selected.
   3. Aggregate Size: No. 0-1.
E. Base: Same type as floors, NTMA Plate No. _____, 1/4 inch thick.
F. Base: Same type and thickness as floors.
   1. Matrix Color: As selected.
   2. Aggregate Color: As selected.
   3. Aggregate Size: No. 0-1.
G. Stairs: Epoxy matrix, NTMA Plate No. _____.
   1. Treads and Landings: Minimum 1/4 inch thick.
   2. Risers: Minimum 1/8 inch thick.
H. Stairs: Epoxy matrix.
   1. Matrix Color: As selected.
   2. Aggregate Color: As selected.
   3. Aggregate Size: No. 0-1.
   4. Treads and Landings: Minimum 1/4 inch thick.
   5. Risers: Minimum 1/8 inch thick.

2.03 MATERIALS
A. Epoxy Matrix: Two component resin and epoxy hardener with mineral filler and color pigment, non-volatile, thermo-setting.
B. Polycrystalline Matrix: Resinous composition for modifying cement, containing color pigment, non-volatile.
C. Polyester Matrix: Two component resin and hardener with mineral filler and color pigment, thermo-setting.
D. Portland Cement: ASTM C150, Type I; white color; modified to NTMA higher compressive strength requirements.

E. Aggregate: Crushed marble, size in accordance with NTMA Plate of standard gradation and uniform coloration.

2.04 ACCESSORIES

A. Divider Strips: 1/8 inch thick zinc exposed top strip, zinc coated steel concealed bottom strip, with anchoring features.
   1. Product: __________ manufactured by __________.

B. Control Joint Strips: 1/8 inch nominal width zinc exposed top strips, zinc coated steel concealed bottom strips, 1/8 inch wide neoprene filler strip between vertical strips, with anchoring features.
   1. Product: __________ manufactured by __________.

C. Divider and Control Joint Strip Height: To suit thickness of terrazzo topping, with allowance for grinding.

D. Base Cap, Base Divider Strip, and Separator Strip: Match divider strips.

   1. Product: __________ manufactured by __________.

F. Cleaner: Neutralizing liquid type, pH of 7.
   1. Product: __________ manufactured by __________.

G. Sealer: Colorless, non-yellowing, penetrating liquid type to completely seal matrix surface; not detrimental to terrazzo components.
   1. Product: __________ manufactured by __________.

H. Wood Subfloor Joint Tape: Cloth type.

I. Subfloor Filler: Latex type.

J. Primer: __________.

2.05 MIXES

A. Topping: Three parts aggregate chip; one part aggregate dust; one part matrix binder and hardener.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive terrazzo.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive terrazzo.

C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of materials to sub-floor surfaces.

D. Verify that wood sub-floors have 12 percent maximum moisture content.

E. Verify that concrete sub-floor surfaces are ready for terrazzo installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by terrazzo materials manufacturer.

F. Verify that concrete sub-floor surfaces are ready for terrazzo installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
   1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.

G. Verify that required floor-mounted utilities are in correct location.
3.02 PREPARATION
   A. Clean substrate of foreign matter.
   B. Apply slurry coat to substrate.
   C. Prepare wood subfloor, tape joints, and apply subfloor joint filler.
   D. Apply primer in accordance with manufacturer's instructions.

3.03 INSTALLATION - ACCESSORIES
   A. Saw cut substrate to install divider and control joint strips.
   B. Install divider and control joint strips straight and level to locations indicated.
   C. Install non-slip inserts in floors where indicated.
   D. Install recessed floor mat frames.
   E. Install base and border divider and control joint strips to match floor pattern.
   F. Install terminating cap strip at top of base; attach securely to wall substrate.
   G. Form ____ inch wide border with divider strips.

3.04 APPLICATION - TERRAZZO
   A. Place terrazzo mix over prepared substrate to thickness indicated.
   B. Flush Vertical Base: Bond topping to wall.

3.05 CURING
   A. Cure terrazzo topping by sheet polyethylene curing method.
   B. Close area to allow undisturbed curing.

3.06 FINISHING
   A. Finish terrazzo to NTMA requirements.
   B. Produce terrazzo finish surface to match approved mockup, with 70 percent chip exposed.
   C. Grind terrazzo surfaces with power disc machine; sequence with coarse to fine grit abrasive, using a wet method.
   D. Apply patch mix to match mortar over ground surface to fill honeycomb exposed during grinding.
   E. Remove patch coat by grinding, using a fine grit abrasive.
   F. Hand grind base and cove similarly.

3.07 TOLERANCES
   A. Maximum Variation from Flat Surface: 1/8 inch in 10 feet.
   B. Maximum Variation from Level (Except Surfaces Sloping to Drain): 1/8 inch.

3.08 CLEANING
   A. Scrub and clean terrazzo surfaces with cleaner in accordance with manufacturer's instructions. Let dry.
   B. Immediately after terrazzo has dried, apply sealer in accordance with manufacturer's instructions.
   C. Seal and polish surfaces, in accordance with manufacturer's instructions.

3.09 PROTECTION
   A. Do not permit construction traffic over finished terrazzo surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Carpet, stretched-in, with cushion underlay and direct-glued.

1.02 REFERENCE STANDARDS
C. CRI (CIS) - Carpet Installation Standard; Carpet and Rug Institute; 2009.
D. CRI (GLA) - Green Label Testing Program - Approved Adhesive Products; Carpet and Rug Institute; Current Edition.
E. CRI (GLP) - Green Label Plus Carpet Testing Program - Approved Products; Carpet and Rug Institute; Current Edition.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate seaming plan, method of joining seams, direction of carpet pile and pattern, location of edge moldings and edge bindings, layout of flat wire system, and ________.
C. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
D. Samples: Submit two samples 24 by 24 inch in size illustrating color and pattern for each carpet and cushion material specified.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
   2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
   3. Credit MR 6: Rapidly Renewable material content for each product. Product cost data.
   4. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
   5. Credit EQ 4.3: Manufacturers’ product data for carpet, carpet cushion, and installation adhesive, including printed statement of VOC content.
F. Manufacturer’s Installation Instructions: Indicate special procedures.
G. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

1.04 FIELD CONDITIONS
A. Store materials in area of installation for minimum period of 24 hours prior to installation.
B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.
C. Ventilate installation area during installation and for 72 hours after installation.

PART 2 PRODUCTS

2.01 CARPET
A. Carpet Type CPT-1:
CARPETING

1. Product: manufactured by .
2. Roll Width: 12 ft.
3. Surface Burning Characteristics: Flame spread/Smoke developed index of / , maximum, when tested in accordance with ASTM E 84.
4. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
5. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
6. VOC Content: Provide CRI Green Label Plus certified product; in lieu of labeling, independent test report showing compliance is acceptable.

2.02 ACCESSORIES
A. Sub-Floor Filler: Modified Portland cement type recommended by carpet manufacturer.
B. Tackless Strip: Carpet gripper, of type recommended by carpet manufacturer to suit application, with attachment devices.
C. Adhesives - General: Compatible with materials being adhered; maximum VOC content of 50 g/L; CRI Green Label certified; in lieu of labeled product, independent test report showing compliance is acceptable.
D. Seam Adhesive: Recommended by manufacturer.
E. Contact Adhesive: Compatible with carpet material; releasable type.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive carpet.
B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet.
C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesives to sub floor surfaces.

3.02 PREPARATION
A. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
B. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
C. Clean substrate.

3.03 INSTALLATION - GENERAL
A. Starting installation constitutes acceptance of sub-floor conditions.
B. Install carpet and cushion in accordance with manufacturer's instructions and CRI Carpet Installation Standard.
C. Verify carpet match before cutting to ensure minimal variation between dye lots.
D. Lay out carpet and locate seams in accordance with shop drawings:
   1. Locate seams in area of least traffic, out of areas of pivoting traffic, and parallel to main traffic.
   2. Do not locate seams perpendicular through door openings.
   3. Align run of pile in same direction as anticipated traffic and in same direction on adjacent pieces.
   4. Locate change of color or pattern between rooms under door centerline.
   5. Provide monolithic color, pattern, and texture match within any one area.
E. Install carpet tight and flat on subfloor, well fastened at edges, with a uniform appearance.
3.04 STRETCHED-IN CARPET
A. Install tackless strips with pins facing the wall around entire perimeter, except across door openings. Use edge strip where carpet terminates at other floor coverings.
B. Space tackless strips slightly less than carpet thickness away from vertical surfaces, but not more than 3/8 inch.
C. Install cushion in maximum size pieces using spot adhesive to adhere to sub-floor.
D. Lay out cushion so that seams will be perpendicular to, or offset from, minimum 6 inches from carpet seams.
E. Butt cushion edges together and tape seams.
F. Trim cushion tight to edge of tackless strip and around projections and contours.
G. Double cut carpet seams, with accurate pattern match. Make cuts straight, true, and unfrayed. Apply seam adhesive to all cut edges immediately.
H. Join seams by hand sewing. Form seams straight, not overlapped or peaked, and free of gaps.
I. Following seaming, hook carpet onto tackless strip at one edge, power stretch, and hook firmly at other edges. Follow manufacturer's recommendations for method and amount of stretch.
J. Trim carpet neatly at walls and around interruptions. Tuck edges into space between tackless strip and wall.

3.05 DIRECT-GLUED CARPET
A. Double cut carpet seams, with accurate pattern match. Make cuts straight, true, and unfrayed. Apply seam adhesive to cut edges of woven carpet immediately.
B. Apply contact adhesive to floor uniformly at rate recommended by manufacturer. After sufficient open time, press carpet into adhesive.
C. Apply seam adhesive to the base of the edge glued down. Lay adjoining piece with seam straight, not overlapped or peaked, and free of gaps.
D. Roll with appropriate roller for complete contact of adhesive to carpet backing.
E. Trim carpet neatly at walls and around interruptions.

3.06 CLEANING
A. Remove excess adhesive from floor and wall surfaces without damage.
B. Clean and vacuum carpet surfaces.

3.07 SCHEDULE
A. CPT-1
   1. Location: Private offices
   2. Manufacturer: Interface
   3. Style: Pebble Menagerie II
   4. Color: Shell
B. CPT-2
   1. Location: Student Unions, Computer Lab, KWVA
   2. Manufacturer: Interface
   3. Style: Pebble Mangerie II
   4. Color: Storm
C. CPT-3
   1. Location: Conference Rooms - Standard
   2. Manufacturer: Tandus
   3. Style: Pebble Mesh
   4. Color: Gritstone 02620
D. CPT-4
   1. Location: Conference Rooms - Premium
CARPETING

2. Manufacturer: Tandus
3. Style: Pebble Mesh
4. Color: Gritstone 02620

E. CPT-5
   1. Location: Rug at Hearth
   2. Manufacturer: Tandus
   3. Style: Pebble Mesh
   4. Color: Gritstone 02620
   5. Size: XXX
   6. Edge: Bound
   7. Backing: Applied non-skid backing

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Carpet tile, loose laid with edges and control grid adhered.
   B. Matching roll carpet for direct glue installation on base.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate layout of joints.
   C. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
   D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
   E. Submit two, ___ inch long samples of edge strip.
   F. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
      3. Credit MR 6: Rapidly Renewable material content for each product. Product cost data.
      4. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
      5. Credit EQ 4.3: Manufacturers’ product data for carpet, carpet cushion, and installation adhesive, including printed statement of VOC content.
   G. LEED Report: Submit data documenting VOC content of carpet tile and adhesives; copy of current CRI Approved Products Listing is acceptable.
   H. Manufacturer's Installation Instructions: Indicate special procedures.
   I. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
   J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.
      2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.
      3. Extra Roll Carpet: ____ sq ft of each type, color, and pattern installed.

1.03 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.
   B. Installer Qualifications: Company specializing in installing carpet with minimum ___ years experience.

1.04 FIELD CONDITIONS
   A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. ____; Product ____.
   B. Other Acceptable Manufacturers:
5. _____; Product _____.
6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS
A. Carpet Tile Type CPT-2: Tufted, manufactured in one color dye lot.
   1. Product: _______ manufactured by _________.
   2. Tile Size: 18 x 18 inch, nominal.
   3. Thickness: _____ inch.
   4. Color: ________.
   5. Pattern: ________.
   6. Surface Burning Characteristics: Flame spread/Smoke developed index of _____/____, maximum, when tested in accordance with ASTM E 84.
   7. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
   8. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
   9. VOC Content: Comply with Section 01 61 16.
10. VOC Content: Provide CRI Green Label Plus certified product; in lieu of labeling, independent test report showing compliance is acceptable.
11. Static Control Fiber: ________.
12. Max. Electrostatic Charge: 3 Kv. at 20 percent relative humidity.
13. Rows: _____ per inch.
15. Stitches: _____ per inch.
17. Pile Weight: _____ oz/sq yd.
19. Light Fastness: ______.
20. Primary Backing Material: Polypropylene.
21. Primary Backing Weight: _____ oz/sq yd.
22. Laminate: ________.
23. Laminate Weight: _____ oz/sq yd.
26. Total Weight: _____ oz/sq yd.

B. Roll Carpet: Same manufacturer, type, color and pattern, and face fiber characteristics as carpet tile, _______ feet wide, manufactured in same color dye lot as tile.

2.03 ACCESSORIES
A. Sub-Floor Filler: Modified Portland cement type recommended by flooring material manufacturer.
B. Base Cap: _______ type, _______ finish, _______ color.
C. Edge Strips: Embossed aluminum, _______ color.
D. Stair Nosing: As specified in Section 09 65 00.
E. Stair Nosing: Rubber type, square nose, ribbed top surface, one piece per stair tread width, _______ finish, _______ color.
F. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC content as specified in Section 01 61 16.
G. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC of 50 g/L; CRI Green Label certified; in lieu of labeled product, independent test report showing compliance is acceptable.
PART 3  EXECUTION

3.01  EXAMINATION
A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.
C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
D. Verify that concrete sub-floor surfaces are dry enough and ready for flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F710; obtain instructions if test results are not within limits recommended by carpet tile manufacturer and adhesive materials manufacturer.
E. Verify that concrete sub-floor surfaces are ready for carpet tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
   1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.
F. Verify that required floor-mounted utilities are in correct location.

3.02  PREPARATION
A. Remove existing carpet tile.
B. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
D. Vacuum clean substrate.

3.03  INSTALLATION
A. Starting installation constitutes acceptance of sub-floor conditions.
B. Install carpet tile in accordance with manufacturer's instructions and CRI Carpet Installation Standard.
C. Install carpet tile in accordance with manufacturer's instructions and CRI 104.
D. Blend carpet from different cartons to ensure minimal variation in color match.
E. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
F. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
G. Locate change of color or pattern between rooms under door centerline.
H. Adhere carpet tile to substrate along centerline of rooms, at perimeter of rooms, where tiles are cut, and at 15 foot intervals throughout rooms. Lay remainder of tile dry over substrate.
I. Adhere carpet tile as base finish up vertical surfaces to form base. Terminate top of base with cap strip.
J. Trim carpet tile neatly at walls and around interruptions.
K. Complete installation of edge strips, concealing exposed edges.

3.04  INSTALLATION ON STAIRS
A. Use one piece of carpet for each tread and the riser below. Apply seam adhesive to all cut edges.
B. Lay carpet with pile direction in the length of the stair.
C. Adhere carpet tight to stair treads and risers.

3.05 CLEANING
A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
B. Clean and vacuum carpet surfaces.

3.06 SCHEDULE
A. WOM- 1
   1. Manufacturer: Burmatex
   2. Style: Academy
   3. Color: Gordonstoun Grey, #11803
B. CPT-1
   1. Location: Private Offices, New Wing and Existing Building
   2. Manufacturer: Interface
   3. Style: Menagerie II
   4. Color: Shell
C. CPT-1
   1. Location: Private Offices, New Wing and Existing Building
   2. Manufacturer: Interface
   3. Style: Menagerie II
   4. Color: Shell
D. CPT-1
   1. Location: Private Offices, New Wing and Existing Building
   2. Manufacturer: Interface
   3. Style: Menagerie II
   4. Color: Shell
E. CPT-1
   1. Location: Private Offices, New Wing and Existing Building
   2. Manufacturer: Interface
   3. Style: Menagerie II
   4. Color: Shell

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surface preparation and prime painting.
B. Wall covering and borders.

1.02 RELATED REQUIREMENTS
A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 09 90 00 - Painting and Coating: Preparation and priming of substrate surfaces.

1.03 PRICE AND PAYMENT PROCEDURES
A. Wall covering work will be accomplished under one or more allowances.
B. See Section 01 21 00 - Allowances, for additional requirements.
C. Allowance includes purchase and delivery only.

1.04 REFERENCE STANDARDS
D. FS L-P-1040 - Plastic Sheets and Strips (Polyvinyl Fluoride); Federal Specifications and Standards; Revision B, 1977.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on wall covering and adhesive.
C. Shop Drawings: Indicate wall elevations with seaming layout.
D. Samples: Submit two samples of wall covering, _____x____ inch in size illustrating color, finish, and texture.
E. Test Reports: Indicate verification of flame and smoke ratings, when tested by UL.
F. Manufacturer's Installation Instructions: Indicate special procedures.
G. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.
H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Wall Covering Materials: 25 linear feet of each color and pattern of wall covering; store where directed.
   3. Package and label each roll by manufacturer, color and pattern, and destination room number.
I. LEED Submittal: Documentation of recycled content and location of manufacture.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.
B. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum __________ years of experience.

1.07 MOCK-UP
A. Provide panel, ___ panel drops wide, full height, illustrating installed wall covering and joint seaming technique.
B. Locate where directed.
C. Mock-up may remain as part of the Work.
1.08 DELIVERY, STORAGE, AND HANDLING
   A. Inspect roll materials at arrival on site, to verify acceptability.
   B. Protect packaged adhesive from temperature cycling and cold temperatures.
   C. Do not store roll goods on end.

1.09 FIELD CONDITIONS
   A. Do not apply materials when surface and ambient temperatures are outside the temperature
   ranges required by the adhesive or wall covering product manufacturer.
   B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall
   covering.
   C. Provide lighting level of 80 ft candles measured mid-height at substrate surfaces.

PART 2 PRODUCTS

2.01 BASE BID MANUFACTURER
   A. ______; Product _____.
   B. Other Acceptable Manufacturers:
      3. ______; Product _____.
      4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS
   A. Requirements for All Wall Coverings:
      1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50,
      maximum, when tested in accordance with ASTM E84.
      2. Chemical and Stain Resistance: No visible staining or discoloration and no damage to
      surface texture when tested in accordance with ASTM D1308.
   B. Wall Covering - Type ___:
      1. Total Thickness: _____ mil.
      2. Total Weight: _____ oz/sq yd.
      4. Roll Width: _____ inches.
      5. Color: ________.
      6. Pattern: ________.
      7. Surface Texture: ________.
      8. Overcoating: Stain resistant, polyvinyl fluoride over-coating, 0.0005 inch thick.
   C. Wall Covering - Type ___:
      1. Panel Size: 4 feet by 8 feet.
      2. Vinyl Thickness: 30 mils (0.030 inch).
      3. Particle Board Thickness: 3/8 inch.
      4. Total Thickness: 13/32 inch.
      5. Panel Edge Treatment: Beveled.
      6. Trim: Beveled; vinyl, match face panel color.
      7. Mounting: Adhesive or manufacturer's demountable clip system.
      8. Color: ________.
      9. Pattern: ________.
      10. Surface Texture: ________.
   D. Wall Covering - Type ___:
      1. Overcoating: Polyvinyl fluoride complying with FS L-P-1040 Type 1, Grade B, Class 2,
      0.0005 inch thick.
   E. Wall Covering: ________, conforming to the following:
      1. Total Thickness: _____ mil.
2. Total Weight: _____ oz/sq yd.
4. Color: ________.
5. Pattern: ________.
6. Surface Texture: ________.

F. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.

G. Termination Trim: Extruded plastic, clear.

H. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

I. Substrate Primer and Sealer: Alkyd enamel type.

PART 3 EXECUTION

3.01 INSTALLERS

A. Acceptable Installers:
   1. ____________________________.
   2. ____________________________.
   3. ____________________________.

3.02 EXAMINATION

A. Verify that substrate surfaces are prime painted and ready to receive work, and conform to requirements of the wall covering manufacturer.

B. Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.

C. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at a rate greater than 1/16 inch/ft.

3.03 PREPARATION

A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.

B. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.

C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

D. Surfaces: Correct defects and clean surfaces that affect work of this section. Remove existing coatings that exhibit loose surface defects.

E. Marks: Seal with shellac those that may bleed through surface finishes.

F. Apply one coat of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.

G. Vacuum clean surfaces free of loose particles.

3.04 INSTALLATION

A. Apply adhesive and wall covering in accordance with manufacturer's instructions.

B. Apply adhesive to wall surface immediately prior to application of wall covering. Let contact adhesive set tack free.

C. Use wall covering in roll number sequence.

D. Razor trim edges on flat work table. Do not razor cut on gypsum board surfaces.

E. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface. Butt edges tightly.

F. Horizontal seams are not acceptable.

G. Do not seam within 2 inches of internal corners or within 6 inches of external corners.

H. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.
I. Do not install wall covering more than 1/4 inch below top of resilient base.
J. Cover spaces above and below windows, above doors, in pattern sequence from roll.
K. Apply wall covering to electrical wall plates prior to replacing.
L. Wall covering is required behind fin tube cabinets.
M. Where wall covering tucks into reveals, or metal wallboard or plaster stops, apply with contact adhesive within 6 inches of wall covering termination. Ensure full contact bond.
N. Install termination trim.
O. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.05 CLEANING
A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
B. Reinstall wall plates and accessories removed prior to work of this section.

3.06 PROTECTION
A. Do not permit construction activities at or near finished wall covering areas.

3.07 SCHEDULES
A. Classroom 201:
1. North, west, and east walls - #31 "Grass Cloth".
2. South accent wall - #44 "Linen".
3. Cover access panels same as walls.
B. Principal's Office:
1. Walls - #12 "Weave".
2. Cover wall plates with #77 "White".

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Site fabricated, fabric-covered acoustical wall system.
   B. Accessories as required for complete installation.
   C. Maintenance.

1.02 RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.
      4. Specimen warranty.
   C. Test Reports: Certified test data from an independent test agency verifying that wall systems meet specified requirements for acoustical and fire performance.
   D. Shop Drawings: Elevations indicating proposed locations of fabric seams and details indicating typical transitions to other finish surfaces.
   E. Selection Samples: Fabric swatches representing manufacturer's full range of available colors, textures, and patterns.
   F. Verification Samples:
      1. For each fabric specified, minimum size 8 inches square, representing actual product in color, texture, and pattern.
   G. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Provide all components of acoustical wall systems by a single manufacturer, including recommended primers, adhesives, and sealants.
   B. Installer Qualifications: Firm specializing in site-fabricated wall systems, with not less than 5 years of documented experience in installing wall systems of the type specified, and approved by the manufacturer.
   C. Surface Burning Characteristics: Provide system with flame spread index of 25, maximum, and smoke developed index of 40, maximum, when tested in accordance with ASTM E84.
   D. Mock-Up: Provide a mock-up for evaluation of application workmanship.
      1. Finish areas designated by Architect.
      2. Do not proceed with remaining work until workmanship and overall appearance are approved by Architect.
      3. Refinish mock-up area as required to produce acceptable workmanship.
      4. Approved mock-up may remain as part of the completed Work.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect fabric, acoustical backing, and track from excessive moisture in shipment, storage, and
      handling. Do not deliver materials to project until wet work such as concrete and plaster has
      been completed.
   B. Store products in manufacturer's unopened packaging until ready for installation.
   C. Store and dispose of solvent-based materials, and materials used with solvent-based materials,
      in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS
   A. Do not begin installation until interior conditions have reached temperature and humidity that
      will be maintained during occupancy. Do not install products under environmental conditions
      outside manufacturer's absolute limits.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a 5-year period after Date of Substantial Completion.

PART 2 PRODUCTS
2.01 ACOUSTICAL WALL SYSTEM
   A. Acoustical Wall System: Site-installed stretched fabric over acoustical core and continuous
      perimeter and intermediate mounting frames applied directly to wall surface; designed to permit
      removal and replacement of fabric in individual panels without affecting adjacent panels.
      1. Surface Burning Characteristics: Flame Spread Index of 25, maximum; Smoke
         Developed Index of 450, maximum; when whole system is tested in accordance with
         ASTM E84 using mounting specified in ASTM E2573.
      2. Noise Reduction Coefficient (NRC): 0.80, minimum, when tested in accordance with
         ASTM C423 Type A mounting.
      3. Prefabricated framed panels are not acceptable.
      4. Fabric must be installed over acoustical substrate without adhesives, tapes, or fasteners.

2.02 MATERIALS
   A. Frame: Extruded polymer track system with serrated jaws of sufficient strength to hold fabric in
      place after repeated applications.
      1. Track Size: AWS-3: 1 inch, AWS-4, 5, 6: 1/2 inch protrusion from wall with minimum 1
         inch base leg.
      2. Track Profile: Square.
      3. Wall Thickness of Track: Minimum 0.062 inch.
      4. Color: As selected from manufacturer's standards.
   B. Acoustical Core:
   C. Rigid Blocking: Fire-retardant treated medium density fiberboard complying with ANSI A208.2.
   D. Fabric: __________.
   E. Fasteners: As recommended by manufacturer of acoustical wall system for project conditions.
   F. Adhesives: Low VOC or water-based, approved by wall system manufacturer, and complying
      with requirements of Section 01 61 16.

PART 3 EXECUTION
3.01 PREPARATION
   A. Clean surfaces thoroughly prior to installation.
   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best
      result for the substrate under the project conditions.
   C. Remove wall plates and other obstacles, and prepare substrates to receive core material in
      accordance with manufacturer's instructions.
3.02 INSTALLATION

A. Install acoustical wall systems at locations indicated, complying with manufacturer’s instructions.

B. Track: Install perimeter and intermediate track using fasteners appropriate to substrate, securing firmly to prevent track separation from substrate.
1. For tile or masonry substrates, apply continuous bead of adhesive in conjunction with conical anchors and fasteners every 6-8 inches.
2. Follow contours of wall and scribe to adjoining work at borders, penetrations, and imperfections.
3. Install track around openings and penetrations.
4. Allow for spacing to accommodate insertion of installation tool.

C. Fabric: Stretch fabric over acoustical core material, locking fabric edges into track's serrated jaws using manufacturer’s recommended tool. Keep fabric weave plumb, level, and true, in proper relation to building lines, without ripples, waviness, hourglass, or other deleterious effects.
1. In installing fabric, do not employ adhesives or mechanical fasteners of any type, assuring that the fabric is free-floating and in firm contact with core material.
2. Tension fabric sufficiently to prevent sagging under anticipated changes in temperature and humidity.

3.03 CLEANING

A. Clean exposed surfaces of acoustical wall system, complying with manufacturer's instructions for cleaning and repair of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.04 PROTECTION

A. Protect installed products until completion of project, using methods that will ensure that the finished work will be without damage or deterioration at Date of Substantial Completion.

3.05 MAINTENANCE

A. Replace damaged, soiled, or vandalized acoustical wall panels for up to 3 years from Date of Substantial Completion.

B. Replacement of up to 10 percent of the originally installed panels shall be at no additional cost to Owner.

C. Replacement of defective panels covered under warranty provisions is not included in this maintenance service.

3.06 SCHEDULE

A. AWS-1
   1. Location: Program Areas
   2. Manufacturer: Acoustical Surfaces Inc.
   3. Style: Sound Silencer
   4. Color: Charcoal
   5. Thickness: 1 inch
   6. Size: 2 inch by 4 inch panel

B. AWS-2
   1. Location: Conference Rooms
   2. Manufacturer: Wood

C. AWS-3
   1. Location: Conference Rooms
   2. Manufacturer: Snap-Tex
   3. Substrate: Fiberglass acoustical and tackable panel
ACOUSTICAL WALL SYSTEMS

4. Thickness: 1 inch
5. Fabric: Knoll Textiles, Reflect, W884/4A, Steel

D. AWS-4
1. Location: Multifunctional Auditorium
2. Manufacturer: Snap-Tex
3. Substrate: Fiberglass acoustical panel with 18 to 20 lb. density high impact face
4. Thickness: 2 inch
5. Fabric: Knoll Textiles, Reflect, W884/2A, Titanium

E. AWS-5
1. Location: Multifunctional Auditorium
2. Manufacturer: Snap-Tex
3. Substrate: Fiberglass acoustical panel with 18 to 20 lb. density high impact face
4. Thickness: 2 inch
5. Fabric: Knoll Textiles, Reflect, W884/3A, Sterling

F. AWS-6
1. Location: Multifunctional Auditorium
2. Manufacturer: Snap-Tex
3. Substrate: Fiberglass acoustical panel with 18 to 20 lb. density high impact face
4. Thickness: 2 inch
5. Fabric: Knoll Textiles, Reflect W884/4A, Steel

G. AWS-7
1. Location: Multifunctional Auditorium
2. Manufacturer: Owens Corning
3. Style: QuietR Duct Liner Board
4. Thickness: 2 inch
5. Fabric: 48 inch by 96 inch

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabric-covered mineral fiber core panels and mounting accessories.
B. Fabric-covered fiberglass core panels and mounting accessories.
C. Fabric-covered mineral fiber core ceiling baffles.
D. Fabric-covered fiberglass core ceiling baffles.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 06 40 00 - Architectural Woodwork.
C. Section 09 51 00 - Acoustical Ceilings.
D. Section 09 51 53 - Direct-Applied Acoustical Ceilings.
E. Section 09 72 00 - Wall Coverings.
F. Section 09 90 00 - Painting and Coating.

1.03 REFERENCE STANDARDS


1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer’s printed data sheets for products specified.
C. Shop Drawings: Fabrication and installation details, panel layout, and fabric orientation.
D. Selection Samples: Manufacturer’s color charts for fabric covering, indicating full range of fabrics, colors, and patterns available.
E. Verification Samples: Fabricated samples of each type of panel specified; 12 x 12 in, showing construction, edge details, and fabric covering.
F. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Panels: Quantity equal to 5 percent of total installed, but not less than one of each type.
G. LEED Submittal: Documentation of recycled content and location of manufacture.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company with not less than 5 years of experience in manufacturing acoustical products similar to those specified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect acoustical panels from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until panels are needed for installation.
B. Store panels flat, in dry, well-ventilated space; do not stand panels on end.
C. Protect panel edges from damage.

1.07 MOCK-UP

A. See Section 01 40 00 - Quality Requirements, for additional mock-up requirements.
B. Construct mock-up of acoustical panels at location indicated by Architect.
   1. Minimum mock-up dimensions: 96 x 96 inches.
2. Approved mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acoustical Panels:

B. Substitutions: See Section 01 60 00 - Product Requirements.

C. Provide all acoustical panels by one manufacturer.

2.02 ACOUSTICAL WALL PANELS

   1. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed
      index of 450 or less, when tested in accordance with ASTM E84.

B. Mineral Fiber Core Panels:
   2. Noise Reduction Coefficient (NRC): 0.50-0.60 when tested in accordance with ASTM
      C423 for Type A mounting, per ASTM E 795.
   4. Panel Width: As detailed.
   5. Panel Height: 48 inches.
   6. Panel Height: As detailed.
   8. Panel Thickness: As required to meet required acoustical performance.
  10. Edges: Perimeter edges reinforced by an aluminum frame or a galvanized steel frame.

C. Fiberglass Core Panels:
   1. Density: 7-10 lb/cu ft.
   2. Noise Reduction Coefficient (NRC): 0.70-0.80 when tested in accordance with ASTM
      C423 for Type A mounting, per ASTM E 795.
   4. Panel Width: As detailed.
   5. Panel Height: 48 inches.
   6. Panel Height: As detailed.
   8. Panel Thickness: As required to meet required acoustical performance.
   9. Edges: Perimeter edges reinforced by an aluminum frame or a galvanized steel frame.

D. Fabric Covering: Seamless fabric facing material, for stretched covering of core material.
   1. Fabric: Owner-supplied.
   2. Fabric: Manufacturer's standard.
   4. Color: As selected by Architect from manufacturer's full range.
   5. Color: As scheduled.
   6. Patterns: Where fabric with directional or repeating patterns or fabric with directional
      weave is used, mark for installation in same direction.
2.03 FABRICATION

A. General: Fabricate panels to sizes and configurations indicated, with fabric facing installed without sagging, wrinkles, blisters, or visible seams.
   1. Where radiused or mitered corners are indicated, install fabric to avoid seams or gathering of material.
   2. For panels suspended from ceiling, provide fabric covering both sides, with seams only at panel edges.

B. Tolerances: Fabricate to finished tolerance of plus or minus 1/16 in for thickness, overall length and width, and squareness from corner to corner.

2.04 ACCESSORIES

A. Spline-Mounting Accessories: Manufacturer's standard concealed connecting splines of extruded aluminum designed for screw attachment to walls, with coordinating moldings and trim for interior and exterior corners and miscellaneous conditions.
   1. Color of Exposed Trim: As selected from manufacturer's standards.

B. Back-Mounting Accessories: Manufacturer's standard accessories for concealed support, designed to allow panel removal, and as follows:
   1. Two-part clip and base-support bracket system; brackets designed to support full weight of panels and clips designed for lateral support, with one part mechanically attached to back of panel and the other attached to substrate.
   2. Metal impaling clips designed to support full weight of panels, mechanically attached to substrate and adhesively bonded to back of panels.
   3. Hook and loop strips adhered to substrate and to back of panels.
   4. Z-clip hanger and magnet system with magnets recessed into panel frame and designed to engage steel mounting plates secured to substrate with screws.
   5. Mechanically Mounted Metal-Framed Panels: Metal panel-clip system designed to engage metal framing of panels.

C. Ceiling-Suspended Accessories: Manufacturer's standard through-threaded eyelets bolted through concealed perimeter frame at 1/4 points on each panel, sized appropriately for weight of panels.
   1. Provide galvanized wire for suspension from ceiling at heights indicated.

D. Trim Moldings: Manufacturer's standard wood or vinyl trim moldings for concealing panel joints; color as selected from manufacturer's standards.

E. Trim Moldings: Custom wood trim moldings as detailed; finish as specified in Section 06 40 00.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates for conditions detrimental to installation of acoustical panels. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install acoustical panels in locations indicated, following installation recommendations of panel manufacturer. Align panels accurately, with edges plumb and top edges level. Scribe to fit accurately at adjoining work and penetrations.

B. Suspend ceiling baffles at locations and heights indicated.

C. Install panels to construction tolerances of plus or minus 1/16 in for the following:
   1. Plumb and level.
   2. Flatness.
   3. Width of joints.

3.03 CLEANING

A. Clean fabric facing upon completion of installation from dust and other foreign materials, following manufacturer's instructions.
B. Remove surplus materials, trimmed portions of panels, and debris resulting from installation.

3.04 PROTECTION

A. Provide protection of installed acoustical panels until completion of the work.
B. Replace panels that cannot be cleaned and repaired to satisfaction of the Architect.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.
B. Field application of paints, stains, varnishes, and other coatings.
C. Surfaces to be finished are indicated in this section and on the Drawings.
D. Surfaces to receive high performance coating are indicated in Section 09 96 00.

1.02 RELATED REQUIREMENTS

A. Section 01 35 15 - LEED Certification Procedures: LEED rating system definition.
B. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
C. Section 05 50 00 - Metal Fabrications: Shop-primed items.
D. Section 05 51 00 - Metal Stairs: Shop-primed items.
E. Section 09 96 00 - High-Performance Coatings.
F. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Painted identification.
G. Section 26 05 53 - Identification for Electrical Systems: Painted identification.

1.03 REFERENCE STANDARDS


1.04 DEFINITIONS

A. Gloss and Sheen Levels: As defined by MPI except this specification uses common names defined below rather than numbered levels:
   1. Flat: Gloss Level 1
   2. Velvet: Gloss Level 2
   3. Eggshell: Gloss Level 3
   4. Satin: Gloss Level 4
   5. Semi-gloss: Gloss Level 5
   6. Gloss: Gloss Level 6
   7. High Gloss: Gloss Level 7

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide complete list of all products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
   2. MPI product number (e.g. MPI #47).
   3. Cross-reference to specified paint system(s) product is to be used in; include description of each system (copy of relevant MPI Manual page is acceptable).
C. Schedule of Paints: List each coating and finish system for all surfaces that require paint. List special washes, surface preparation, sealers, primers, intermediate coats and final coats.
   1. Identify each material by the manufacturer's catalog number and general classification.
   2. List dry film thickness for each coat in each finish system.
3. Identify minimum total dry film thickness for each system.

D. Certification by listed Manufacturer's Representative that products comply with Contract Documents and are compatible with applicable substrates and with each other.

E. Certification: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.

F. Samples: Submit three paper "drop" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
1. Where sheen is specified, submit samples in only that sheen.
2. Where sheen is not specified, submit each color in each sheen available.

G. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
1. Credit MR 3: Salvaged, refurbished or reused materials; product cost data.
3. Credit MR 5: List products that are extracted, harvested or recovered as well as manufactured within 500 straight-line miles of Project Site, or percent of regional material by weight. Include address and distance of material source and product manufacture. Product cost data.
4. Credit EQ 4.1: Manufacturers' product data for adhesives and sealants, including printed statement of VOC content.
5. Credit EQ 4.2: Manufacturers' product data for paints and coatings, including printed statement of VOC content and list of prohibited chemical quantities.

H. LEED Report: VOC content of all interior opaque coatings actually used.

I. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.06 QUALITY ASSURANCE

2. Certified testing reports for all GS-11 requirements by independant testing agency may be accepted in lieu of GreenSeal Label.

B. Acceptable Manufacturers and Manufacturer's Representative: Direct employee of Manufacturer who is authorized by Manufacturer to perform duties specified in this Section:
1. Benjamin Moore & Company: Randy E. Tessman, CSI CDT
2. Glidden Professional: Terry Decker, CSI, CDT, LEED AP
3. Miller Paint Company: Amy Tacke, CSI, LEED AP, IIDA
4. PPG Architectural Finishes: Raymond V. Nicholson, CSI CDT
5. Rodda/Cloverdale: Jeff McIntyre, CSI CDT
6. Sherwin-Williams: Brian Keil, CSI, CCPR
7. Yolo Colorhouse, LLC: DJ Widmer

1.07 MOCK-UP

A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.

B. Provide wall panel, 10 feet long by 10 feet wide, illustrating coating color, texture, and finish.

C. Provide door and frame assembly illustrating coating color, texture, and finish.

D. Locate where directed.

E. Mock-up may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.09 FIELD CONDITIONS
A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

E. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.

F. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.10 EXTRA MATERIALS
A. See Section 01 60 00 - Product Requirements, for additional provisions.

B. Supply 1 gallon of each color; store where directed.

C. Label each container with color in addition to the manufacturer's label.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Acceptable Manufacturers are listed in Part 1, Quality Assurance.
   1. Substitution Requests for Manufacturer will not be accepted.
   2. Submit Substitution Requests for paint systems by acceptable Manufacturer per Section 01 60 00.

B. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
   1. Coordinate shop applied metal primers and intermediate coats with work in Division 05.

C. Provide all paint and coating products from the same manufacturer to the greatest extent possible.

D. In the event that a single manufacturer cannot provide all specified products, minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
   1. Substitution of other products by the same manufacturer is preferred over substitution of products by a different manufacturer.

2.02 MATERIALS - GENERAL
A. Volatile Organic Compound (VOC) Content and minimum quality:
   1. Provide coatings that comply with the most stringent requirements specified in the following:
      a. Green Seal Standards GS-11 and GC-03, South Coast Air Quality Management District Rule 1113, specifically:
         1) Opaque Topcoats, Flat: 50 g/L, maximum.
         2) Opaque Topcoats, Nonflat: 150 g/L, maximum.
         3) Anti-Corrosive paint: 250 g/L, maximum.
         4) Floor coating: 100 g/L, maximum.
         5) Clear varnish: 350 g/L, maximum.
6) Sanding sealer: 275 g/L, maximum.
7) Waterproofing sealer: 250 g/L, maximum.
8) Other sealers: 200 g/L, maximum.
9) Stains: 250 g/L, maximum.

2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), inclusive of colorants added to a tint base and exclusive of water added at project site; or other method acceptable to authorities having jurisdiction.

B. Chemical Content: The following compounds are prohibited:
   1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

   1. Provide Manufacturer's highest quality product in MPI category.
   2. Provide ready mixed paints and coatings, except field-catalyzed coatings.
   3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
   4. Products in containers with GreenSeal Label.

D. Accessory Materials: Sealers, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

E. Patching Material: Latex filler.

F. Fastener Head Cover Material: Latex filler.

2.03 PAINT SYSTEMS
A. Provide Premium Grade systems (2 top coats) as defined in MPI Architectural Painting Specification Manual, except as otherwise indicated.
   1. Where a specified paint system does not have a Premium Grade, provide Custom Grade system.

B. Where sheen is not specified or more than one sheen is specified, sheen will be selected during Submittals by Architect from the manufacturer's full line.

C. Provide colors as directed by Architect.

2.04 EXTERIOR PAINT SYSTEMS
A. Asphalt Paving Marking:
   1. EXT 2.1B Alkyd/Traffic Marking: MPI #32.

B. Concrete Vertical and Overhead Surfaces:
   1. Applications include but are not limited to walls, soffits, and underside of balconies.
   2. PT: EXT 3.1C, W.B. Light Industrial Coating: MPI #110, gloss level 3.

C. Concrete Paving Marking:
   1. PT: EXT 3.2E Latex Zone / Traffic Marking: MPI #97.

D. Concrete Sealer:
   1. _____: EXT 3.2G Sealer, Clear: MPI #104.

E. Cementitious Composition Board:
   1. PT: EXT 3.3C W.B. Light Industrial Coating: MPI #110, gloss level 3.

F. Clay Masonry Units:
   1. _____: EXT 4.1D Epoxy: Epoxy MPI #77, gloss.

G. Concrete Masonry Units:
   1. _____: EXT 4.2C W.B. Light Industrial Coating: Block Filler MPI #4, W.B. Light Industrial Coating MPI #161, #163, or #164.
   2. _____: EXT 4.2G Polyurethane, Pigmented (over high build epoxy): Epoxy Block Filler MPI #116, High Build Epoxy MPI #108, Polyurethane MPI #72.
H. Structural Steel and Metal Fabrications:
1. _____: EXT 5.1B W.B. Light Industrial Coating: Inorganic Zinc MPI #19, W.B. Light Industrial Coating MPI #161, #163, or #164.
2. _____: EXT 5.1C W.B. Light Industrial Coating: Alkyd Metal Primer MPI #79, W.B. Light Industrial Coating MPI #161, #163, or #164.
3. _____: EXT 5.1D Alkyd: Alkyd Metal Primer MPI #79, Alkyd MPI #8 with MPI VOC Range of below 25.
4. _____: EXT 5.1F Epoxy (over H.B. epoxy): Epoxy Primer MPI #101, High Build Epoxy MPI #108, Epoxy #77.
5. PT: EXT 5.1N. W.B. Light Industrial Coating: Epoxy Primer MPI #101, W.B. Light Industrial Coating MPI #110, gloss level 5.

I. Steel Subject to High Temperature:
1. _____: EXT 5.2D High Heat Resistant Coating: High Heat Resistant Coating MPI #22.

J. Galvanized Metal, Not Chromate Passivated:
1. Applications include but are not limited to doors and frames.

K. Aluminum:
1. _____: EXT 5.4G W.B. Light Industrial Coating: Q.D. Primer MPI #95, W.B. Light Industrial Coating MPI #161, #163, or #164.

L. Copper:
1. _____: EXT 5.5G W.B. Light Industrial Coating: Q.D. Primer MPI #95, W.B. Light Industrial Coating MPI #161, #163, or #164.

M. Stainless Steel:
1. _____: EXT 5.6G W.B. Light Industrial Coating: Q.D. Primer MPI #95, W.B. Light Industrial Coating MPI #161, #163, or #164.

N. Glue Laminated Timber:
1. Applications include but are not limited to beams.
2. _____: EXT 6.1A Latex: Oil/Alkyd Primer MPI #5 or 7, Latex MPI #10, 11, 15 or 119.

O. Dimension Lumber:
1. Applications include but are not limited to columns, beams, exposed joists, underside of decking, and siding.
2. _____: EXT 6.2A Latex: Oil/Alkyd Primer MPI #5 or 7, Latex MPI #10, 11 or 119.
3. _____: EXT 6.2H Polyurethane, Clear, 2 Component: Polyurethane MPI #78.
4. _____: EXT 6.2J Polyurethane, Pigmented: Polyurethane MPI #72, gloss.

P. Dressed Lumber:
1. Applications include but are not limited to doors, smooth fascia, and trim.
3. STN: Transparent Stain: Timber Pro UV natural oil wood finish, preservative, penetrating sealer, UV protector.
   a. Transparent Stain Color: Selected from full range.
5. PT: EXT 6.3J W.B. Light Industrial Coating: Oil/Alkyd Primer MPI #5 or 7, W.B. Light Industrial Coating MPI #110, gloss level 5.

Q. Wood Paneling Surfaces:
1. Applications include but are not limited to Plywood siding.
2. _____: EXT 6.4A Solid Color Stain W.B.: Primer MPI #5, #6 or #7, Latex Stain MPI #16.

R. Fiberglass:
1. _____: EXT 6.7C W.B. Light Industrial Coating: Bonding Primer MPI #69, W.B. Light Industrial Coating MPI #161, #163, or #164.

S. Plastic (ABS, PVC, and PVA):
1. _____: EXT 6.8C W.B. Light Industrial Coating: Bonding Primer MPI #17 or 69, W.B. Light Industrial Coating MPI #161, #163, or #164.
T. Stucco Walls and Soffits:
   1. PT: EXT 9.1B W.B. Light Industrial Coating: W.B. Light Industrial Coating MPI #110, gloss level 3.

2.05 INTERIOR PAINT SYSTEMS

A. Concrete Vertical and Overhead Surfaces:
   1. INT 3.1M Institutional Low Odor/VOC: Institutional Low Odor/VOC MPI #145, gloss level 3.

B. Concrete Pavement Marking:
   1. INT 3.2H Latex Zone / Traffic Marking: Latex Traffic Marking Paint MPI #97.

C. Cementitious Composition Board:
   1. INT 3.3G Institutional Low Odor/VOC: Institutional Low Odor/VOC MPI #145, gloss level 3.

D. Clay Masonry Units:
   1. INT 4.1C W.B. Light Industrial Coating: Alkali Resistant Primer MPI #3, W.B. Light Industrial Coating MPI #151, #153, or #154.

E. Concrete Masonry Units:
   1. INT 4.2E Institutional Low Odor/VOC: Latex Block Filler MPI #4, Institutional Low Odor/VOC MPI #145, gloss level 3.
   2. INT 4.2G Epoxy, W.B.: Epoxy Block Filler MPI #116, Epoxy MPI #77, gloss.
   3. INT 4.2K W.B. Light Industrial Coating: Block Filler MPI #4, MPI #110, gloss level 3, 5 or 6.

F. Structural Steel and Metal Fabrications:
   1. INT 5.1N W.B. Light Industrial Coating: Epoxy Primer MPI #101, W.B. Light Industrial Coating MPI #110, gloss level 3, 5 or 6.

G. Steel Subject to High Temperatures:
   1. INT 5.2D High Heat Resistant Coating: High Heat Resistant Coating MPI #22.

H. Galvanized Metal, Not Chromate Passivated:
   1. Applications include but are not limited to doors, frames, railings, and piping.
   2. INT 5.3K W.B. Light Industrial Coating: Waterborne Primer MPI #134, W.B. Light Industrial Coating MPI #110, gloss level 5.

I. Aluminum (Not Anodized):
   1. Applications include but are not limited to frames, sash, sills, flashing, handrails, railings, and posts.
   2. INT 5.4A Alkyd: Vinyl Wash Primer MPI #80, Alkyd MPI #47, 48, 49 or 51.

J. Copper:
   1. INT 5.5E W.B. Light Industrial Coating: Q.D. Primer MPI #95, W.B. Light Industrial Coating MPI #151, #153, or #154.

K. Stainless Steel (Not Polished or Brushed):
   1. INT 5.6A W.B. Light Industrial Coating: Bonding Primer MPI #69, W.B. Light Industrial Coating MPI #151, #153, or #154.

L. Glue Laminated Timber:
   1. Applications include but are not limited to beams and columns.
   2. STN or CLR: WB Clear Polyurethane over stain (system not listed by MPI): Stain where indicated and 3 coats polyurethane.
      a. Basis of Design: Timber Pro UV, Crystal Urethane, non-yellowing, 145 g/L VOC.
      b. Stain: Manufacturer's compatible product, color selected from full range.
   3. INT 1Q Institutional Low Odor/VOC: Latex Primer MPI #39, Institutional Low Odor/VOC MPI #145, gloss level 3.

M. Dimension Lumber:
PAINTING AND COATING

1. Applications include but are not limited to columns, beams, exposed joists, and underside of decking:
2. STN or CLR: WB Clear Polyurethane over stain (system not listed by MPI): Stain where indicated and 3 coats polyurethane.
   a. Basis of Design: Timber Pro UV, Crystal Urethane, non-yellowing, 145 g/L VOC.
   c. Stain: Manufacturer's compatible product, color selected from full range.

N. Dressed Lumber:
1. Applications include but not limited to doors, door frames, window frames, window casings, trim, baseboards, and moldings.
2. STN or CLR: WB Clear Polyurethane over stain (system not listed by MPI): Stain where indicated and 3 coats polyurethane.
   a. Basis of Design: Timber Pro UV, Crystal Urethane, non-yellowing, 145 g/L VOC.
   c. Stain: Manufacturer's compatible product, color selected from full range.
3. PT: INT 6.3V Institutional Low Odor/VOC: Latex Primer MPI #39, Institutional Low Odor/VOC MPI #147, gloss level 5.

O. Woodwork (Not Floors or Stairs):
1. Applications include but are not limited to paneling, partitions, casework, cabinets, and trim:
2. STN or CLR: WB Clear Polyurethane over stain (system not listed by MPI): Stain where indicated and 3 coats polyurethane.
   a. Basis of Design: Timber Pro UV, Crystal Urethane, non-yellowing, 145 g/L VOC.
   b. Stain: Manufacturer's compatible product, color selected from full range.
3. PT: INT 6.4T Institutional Low Odor/VOC: Latex Primer MPI #39, Institutional Low Odor/VOC MPI #147, gloss level 5.

P. Wood Floors and Stairs:
1. INT 6.5J Polyurethane, Moisture Cured, (over Stain): Semi-Transparent Stain MPI #90, Polyurethane MPI #31, gloss.

Q. Wood Shingles and Shakes:
1. INT 6.6C Semi-Transparent Stain: Wood Stain MPI #90.

R. Fiberglass:
1. Applications include but are not limited to decorative parts, posts, beams, pipes, and pipe covers.
2. INT 6.7A Latex: Bonding Primer MPI #17 or 69, Latex MPI #43, 44, 52, 53, 54 or 114.

S. Plastic (PVC, PVA):
1. Applications include but are not limited to trim and plastic lumber.
2. INT 6.8A High Performance Architectural Latex: Bonding Primer MPI #69 or 17, HIPAC Latex MPI #138, 139, 140 or 141.

T. Spray Textured Ceilings:
1. INT 9.1E Latex: Latex #43, 44, 52, 53, 54 or 114.

U. Plaster and Gypsum Board:
1. Applications include but are not limited to walls, ceilings, soffits, and bulkheads.

V. Acoustic Panels and Tiles:
1. INT 9.3A Latex, Flat: Latex Flat Paint MPI #53.
PART 3 EXECUTION

3.01 SCOPE -- SURFACES TO BE FINISHED

A. Paint all exposed surfaces except where indicated not to be painted or to remain natural; the term "exposed" includes areas visible through permanent and built-in fixtures when they are in place.

B. Paint the surfaces described in PART 2, indicated on the Drawings, and as follows:
   1. If a surface, material, or item is not specifically mentioned, paint in the same manner as similar surfaces, materials, or items, regardless of whether colors are indicated or not.
   2. Paint surfaces behind movable equipment and furnishings the same as similar exposed surfaces.
   3. Paint surfaces to be concealed behind permanently installed fixtures, equipment, and furnishings, using primer only, prior to installation of the permanent item.
   4. Paint back sides of access panels and removable and hinged covers to match exposed surfaces.
   5. Paint interior surfaces of air ducts and convectors and baseboard heating cabinets with flat, nonspecular black paint where visible through registers, grilles, or louvers.
   6. Paint dampers exposed behind louvers, grilles, and convectors and baseboard cabinets to match face panels.

C. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically noted; factory-primed items are not considered factory-finished.
   2. Items indicated to receive other finish.
   3. Items indicated to remain naturally finished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.

3.02 EXAMINATION

A. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials; report incompatible primer conditions and submit recommended changes for Architect's approval.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
   1. Plaster and Gypsum Board: 12 percent.
   2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
   3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
   4. Exterior Wood: 15 percent, measured in accordance with ASTM D4442.
   5. Concrete Floors: 8 percent.

E. Measure the ph factor of concrete, masonry, and mortar before starting any finishing process, using the method specified in MPI Architectural Painting Manual.
   1. Report results in writing to Architect before starting work.
   2. If results of test indicates need for remedial action, provide written description of remedial action. If a different primer or paint systems is required, state the total cost of the change. Do not proceed with remedial action or change without receiving written authorization from Architect.

3.03 PREPARATION

A. Prepare surfaces as specified in MPI Architectural Painting Specification Manual and as follows for the applicable surface and coating; if multiple preparation treatments are specified, use as many as necessary for best results; where the Manual references external standards for preparation (e.g. SSPC standards), prepare as specified in those standards; comply with coating manufacturer's specific preparation methods or treatments, if any.
B. Coordinate painting work with cleaning and preparation work so that dust and other contaminants do not fall on newly painted, wet surfaces.

C. Surface Appurtenances: Prior to preparing surfaces or finishing, remove electrical plates, hardware, light fixtures, light fixture trim, escutcheons, machined surfaces, fittings, and similar items already installed that are not to be painted.
   1. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before preparation and finishing.
   2. After completing painting in each space or area, reinstall items removed using workers skilled in the trades involved.

D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.

E. Marks: Seal with shellac those which may bleed through surface finishes.

F. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

G. Concrete, Cement Plaster and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

H. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

I. Plaster Surfaces to be Painted: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

J. Aluminum Surfaces to be Painted: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.

K. Copper Surfaces to be Painted: Remove contamination by steam, high pressure water, or solvent washing. Apply vinyl etch primer immediately following cleaning.

L. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

M. Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

N. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

O. Interior Wood Items to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

P. Interior Wood Items to Receive Transparent Finish: Sand wood to obtain a uniform appearance before immediately starting work. Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.

Q. Exterior Wood to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied. Back prime concealed surfaces before installation.
R. Exterior Wood to Receive Transparent Finish: Remove dust, grit, and foreign matter; seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes with tinted exterior calking compound after sealer has been applied. Prime concealed surfaces.

S. Glue-Laminated Beams: Prior to finishing, wash surfaces with solvent, remove grease and dirt.

3.04 APPLICATION

A. Apply products in accordance with manufacturer's instructions and as specified or recommended by MPI Manual, using the preparation, products, sheens, textures, and colors as indicated.
   1. Remove, refinish, or repaint work not complying with requirements.

B. Do not apply finishes over dirt, rust, scale, grease, moisture, scuffed surfaces, or other conditions detrimental to formation of a durable coating film; do not apply finishes to surfaces that are not dry.

C. Use applicators and methods best suited for substrate and type of material being applied and according to manufacturer's instructions.
   1. Brush Application: Use brushes best suited for the type of material applied; use brush of appropriate size for the surface or item being painted; produce results free of visible brush marks.
   2. Roller Application: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
   3. Spray Application: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
   4. Where application method is listed in the MPI Manual for the paint system that application method is required; otherwise any application method recommended by manufacturer for material used and objects to be painted is acceptable.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate; provide total dry film thickness of entire system as recommended by manufacturer.
   1. Number of coats and film thickness required are the same regardless of application method.
   2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance.
   3. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive dry film thickness equivalent to that of flat surfaces.

E. Apply finish to completely cover surfaces with uniform appearance without brush marks, runs, sags, laps, ropiness, holidays, spotting, cloudiness, or other surface imperfections.
   1. Before applying finish coats, apply a prime coat of material recommended by manufacturer, unless the surface has been prime coated by others; where evidence of suction spots or unsealed areas in first coat appear, recoat primed and sealed surfaces to ensure finish coat with no burn through or other defects due to insufficient sealing.
   2. Apply first coat to surface that has been cleaned, pretreated, or otherwise prepared as soon as practical after preparation and before subsequent surface deterioration.
   3. Do not apply succeeding coats until the previous coat has cured as recommended by manufacturer.
   4. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat will not cause the undercoat to lift or lose adhesion.
   5. If manufacturer's instructions recommend sanding to produce a smooth, even surface, sand between coats.
   6. Before applying next coat vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
   7. Pigmented (Opaque) Finishes on Doors, Frames, Trim: Provide smooth, opaque surface of uniform finish, color, appearance, and coverage.
   8. Transparent Finishes: Smooth, glass-like.
9. Stippled Finish on Walls, Ceilings, Soffits: Roll and redistribute paint to even, fine texture; leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections; back roll final coat to achieve a uniform surface.

3.05 CLEANING AND PROTECTION
A. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.
B. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from site.
C. Protect other work, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting as approved by Architect.
D. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in MPI Manual.

3.06 SCHEDULE
A. PT-1
1. Location: General Wall Color
2. Manufacturer: Sherwin Williams
3. Color: SW 7007 Ceiling Brilliant White
B. PT-2
1. Location: Wall and Ceiling at Craft Center
2. Manufacturer: Parker Paint ColorLife CL
3. Color: 3232W Tinman
C. PT-3
1. Location: Restroom Ceilings
2. Manufacturer: Sherwin Williams
3. Color: SW 6918 Humorous Green
D. PT-4
1. Location: Program Accent Paint
2. Manufacturer: Sherwin Williams
3. Color: SW7052 Gray Area
E. PT-5
1. Location: Program Accent Paint
2. Manufacturer: Sherwin Williams
3. Color: SW7046 Anonymous
F. PT-6
1. Location: Program Accent Paint
2. Manufacturer: Sherwin Williams
3. Color: SW6712 Luau Green
G. PT-7
1. Location: Program Accent Paint
2. Manufacturer: Sherwin Williams
3. Color: SW6711 Parakeet
H. PT-8
1. Location: Program Accent Paint
2. Manufacturer: Sherwin Williams
3. Color: SW6698 Kingdom Gold
I. PT-9
1. Location: Program Accent Paint
2. Manufacturer: Sherwin Williams
3. Color: SW6696 Quilt Gold

J. PT-10
   1. Location: TBD
   2. Manufacturer: TBD
   3. Color: TBD

K. PT-11
   1. Location: TBD
   2. Manufacturer: TBD
   3. Color: TBD

L. PT-12
   1. Location: TBD
   2. Manufacturer: TBD
   3. Color: TBD

M. PT-13
   1. Location: Painted Gypsum Board Ceilings
   2. Manufacturer: Sherwin Williams
   3. Color: TBD

N. PT-14
   1. Location: Painted Exposed Structure at O Lounge
   2. Manufacturer: Sherwin Williams
   3. Color: TBD

O. PT-15
   1. Location: Auditorium Ceiling
   2. Manufacturer: Parker Paint Color Life CL
   3. Color: 3177N Boundary

P. PT-16
   1. Location: Door Frames
   2. Manufacturer: TBD
   3. Color: TBD

Q. PT-17
   1. Location: Structural Steel
   2. Manufacturer: TBD
   3. Color: TBD

R. PT-18
   1. Location: Handrails
   2. Manufacturer: TBD
   3. Color: TBD

S. EPT-1
   1. Location: General Wall Color - Epoxy Paint to match PT-1
   2. Manufacturer: Benjamin Moore
   3. Color: Brilliant White

T. EPT-2
   1. Not Used

U. STN-3
   1. Not Used

V. STN-4
   1. Not Used

W. STN-5
   1. Not Used

X. STN-6
PAINTING AND COATING

1. Not Used

Y. STN-7
1. Not Used

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. High performance coatings.
   B. Special preparation of surfaces.
   C. Section includes option for thermally fused shop finish in lieu of liquid coatings.

1.02 REFERENCE STANDARDS
   B. SSPC-SP 5 - White Metal Blast Cleaning; Society for Protective Coatings; 2007.

1.03 SUBMITTALS
   A. Product Data: For each product indicated.
   B. Samples for Verification: For each type of coating system and in each color and gloss of finish coat indicated.
      1. Samples on ¼ inch thick steel plate, 8 by 12 inches.
      2. Step coats on Samples to show each coat required for system.
      3. Label each coat of each Sample.
      4. Label each Sample for location and application area.
   C. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and Section 01 60 00.
      2. Credit MR 5: Straight-line distance to Manufacturer and distance to source of material for each product. Product cost data if less than 501 miles. If distance is greater than 500 miles, report “>500”.
      3. Credit EQ 4.1: Manufacturers’ product data for adhesives and sealants, including printed statement of VOC content.
      4. Credit EQ 4.2: Manufacturers’ product data for paints, including printed statement of VOC content and list of prohibited chemical quantities.

1.04 QUALITY ASSURANCE
   A. Master Painters Institute (MPI) Standards:

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
      1. Maintain containers in clean condition, free of foreign materials and residue.
      2. Remove rags and waste from storage areas daily.

1.06 PROJECT CONDITIONS
   A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 55 and 90 deg F.
   B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
PART 2 - PRODUCTS

2.01 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. Provide products of same manufacturer for each coat in a coating system.

B. Chemical Components of Interior Paints and Coatings: Provide products that comply with the following limits for VOC content when calculated according to 40 CFR 58, Subpart D (EPA Method 24) and the following chemical restrictions:
   1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
   2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.
   3. Anticorrosive Coatings: VOC content of not more than 250 g/L.
   4. Stains: VOC content of not more than 250 g/L.
   5. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing 1 or more benzene rings).
   6. Restricted Components: Paints and coatings shall not contain any of the following:
      a. Acrolein.
      b. Acrylonitrile.
      c. Antimony.
      d. Benzene.
      e. Butyl benzyl phthalate.
      f. Cadmium.
      g. Di (2-ethylhexyl) phthalate.
      h. Di-n-butyl phthalate.
      i. Di-n-octyl phthalate.
      j. 1,2-dichlorobenzene.
      k. Diethyl phthalate.
      l. Dimethyl phthalate.
      m. Ethylbenzene.
      n. Formaldehyde.
      o. Hexavalent chromium.
      p. Isophorone.
      q. Lead.
      r. Mercury.
      s. Methyl ethyl ketone.
      t. Methyl isobutyl ketone.
      u. Methylene chloride.
      v. Naphthalene.
      w. Toluene (methylbenzene).
      x. 1,1,1-trichloroethane.
      y. Vinyl chloride.

C. Coordinate selection of shop primer with selection of intermediate and top coatings. Product shall comply with requirements in this Section.

2.02 GLAZE COATING FOR STEEL

A. 3-Coat System:
   1. Zinc-rich epoxy primer, 2.5 to 3.0 dry film mils.
   2. High-build epoxy intermediate coat, 4.0 to 6.0 dry mils.
   3. Pigmented aliphatic urethane top coat, 2.0 to 3.0 mils dry film thickness.

B. Color: Match Architect's sample.

C. Gloss: Semi-gloss, MPI GL-5.
D. Performance Requirements: AAMA 2604.

E. Warranty: Remove and replace defective coating system within 5 year warranty period.

F. Basis of Design: Tnemec system as follows:
   1. Primer: 90-97
   3. Top: Series 73

G. Acceptable Manufacturer’s: Comparable products and system from one of the following:
   1. Benjamin Moore.
   2. Carboline.
   3. PPG Architectural Finishes, Inc.
   5. Tnemec.

2.03 SHOP FINISHING

A. Prepare and apply primers in shop.


C. Optional Shop Finish: Thermally fused 3-coat system comparable to specified liquid system.
   1. Provide same dry film thicknesses, color and gloss.
   2. Submit system for approval per Section 01600, Substitution Request.

D. Deliver lintels individually wrapped in recyclable protective covering.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
   1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
   2. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
   3. Coating application indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Comply with manufacturer’s written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated, but not less than specified.

B. Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants.

D. Coordination of shop-applied prime coats with high-performance coatings is critical.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.

E. Steel Substrates: Remove rust and loose mill scale.
   1. Blast clean according to SSPC-SP 6/NACE No. 3, “Commercial Blast Cleaning.”
   2. Field Touch-up: SSPC-SP 3 “Power tool cleaning.”

3.03 PREPARATION OF HOT-DIP GAVANIZED STEEL FOR PAINTING AND COATING

A. Eliminate the use of post-galvanizing treatments detrimental to paint and coating adhesion.
3.04 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions.
   1. Use applicators and techniques suited for coating and substrate indicated.
   2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

B. Comply with additional requirements in Division 05 for steel preparation and priming.

C. Apply primer to steel as soon as possible after surface preparation, same day and within 8 hours.

D. Apply subsequent coats within Manufacturer's recommended recoat time for previous coat.
   1. Comply with Manufacturer's recommended surface preparation when recoat time is exceeded.

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

F. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

G. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.05 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Markerboards and Tackboards.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's data on chalkboard, dry erase wallcovering, and sliding door hardware.
   C. Shop Drawings: Indicate wall elevations, dimensions, joint locations, special anchor details.
   D. Samples: Submit two samples 6 by 6 inch in size illustrating materials and finish, color and texture of chalkboard and dry erase wallcovering.
   E. Manufacturer's printed installation instructions.
   F. Maintenance Data: Include data on regular cleaning, stain removal.

1.03 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide 20 year warranty for chalkboard and markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Chalk Boards:
      1. Panel Processing, Inc.
      2. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Dry Erase Wallcovering
      1. Walltakers
      2. Substitutions: See Section 01 60 00 - Product Requirements.
   C. Sliding Door Hardware:
      1. Krown Lab
      2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 VISUAL DISPLAY BOARDS
   A. Chalkboards: Chalkboard enamel on hardboard.
      1. Color: Black
      2. Hardboard Face Sheet Thickness: 1/4 inch.
      3. Height: 48 inches.
      4. Length: 8 feet, in one piece.
   B. Dry Erase Wallcovering:
      1. Style: Erase-Rite
      2. Backing: Non-woven
      3. Color: 90 Light Gray
      4. Roll width: 50 inch
   C. Sliding Door Hardware:
      1. Style: Oden custom for by-passing panels
      2. Mounting: Face Mount
      3. Finish: Black Stainless
      4. Accessories: Bottom Guide Track, Black Stainless finish

2.03 MATERIALS
   A. Hardboard for Chalk Surface: AHA A135.4. Tempered type.
   B. Adhesives: Type used by manufacturer.
2.04 ACCESSORIES
   A. Temporary Protective Cover: Sheet polyethylene, 8 mil thick.
   B. Mounting Brackets: Concealed.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.02 INSTALLATION
   A. Install boards in accordance with manufacturer's instructions.
   B. Secure units level and plumb.

3.03 CLEANING
   A. Clean board surfaces in accordance with manufacturer's instructions.
   B. Cover with protective cover, taped to frame.
   C. Remove temporary protective cover at date of Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Solid plastic toilet compartments.
B. Urinal and Vestibule screens.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
C. Product Data: Provide data on panel construction, hardware, and accessories.
D. Samples: Submit two samples of partition panels, _____x____ inch in size illustrating panel finish, color, and sheen.
E. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED credits. Requirements and definitions are located in Section 01 35 15 and section 01 60 00. Submit in PDF format:
   1. Credit MR 4: Recycled content for each product, post-consumer and post-industrial. Product cost data
   2. Credit MR 5: List Products that are extracted, harvested or recovered as well as manufactured within 500 straight line miles of Project Site, or percentage of regional material by weight. Include address and distance of material source and product manufacture, product cost data.
F. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Solid Plastic Toilet Compartments:
   5. Substitutions: Section 01 60 00 - Product Requirements.

2.02 SOLID PLASTIC TOILET COMPARTMENTS
A. Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid molded high density polyethylene (HDPE), floor-mounted unbraced.
B. Doors:
   1. Thickness: 1 inch.
   2. Width: 24 inch.
   4. Height: 55 inch.
C. Panels:
   1. Thickness: 1 inch (25 mm).
   2. Height: 55 inch.
D. Pilasters:
   1. Thickness: 1 inch (25 mm).
   2. Width: As required to fit space; minimum 3 inches (76 mm).

2.03 ACCESSORIES
A. Pilaster Shoes: Formed chromed steel with polished finish, 3 in high, concealing floor fastenings.
B. Pilaster Brackets: Polished stainless steel.
C. Wall Brackets: Continuous type, polished stainless steel.
D. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.

E. Hardware: Polished stainless steel:
   1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
   2. Door Latch: Slide type with exterior emergency access feature.
   3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
   4. Coat hook with rubber bumper; one per compartment, mounted on door.
   5. Provide door pull for outswinging doors.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify correct spacing of and between plumbing fixtures.
   C. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION
   A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
   B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.
   C. Attach panel brackets securely to walls using anchor devices.
   D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.03 TOLERANCES
   A. Maximum Variation From True Position: 1/4 inch.
   B. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING
   A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
   B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.
   C. Adjust adjacent components for consistency of line or plane.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Acoustic operable panel partition.
B. Ceiling track, ceiling guards, and operating hardware.
C. Electric operator.

1.02 REFERENCE STANDARDS
C. ASTM E413 - Classification for Rating Sound Insulation; 2010.
F. ASTM F793 - Standard Classification of Wallcovering by Use Characteristics; 2010a.
G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.
H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 508A - Industrial Control Panels.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on partition materials.
C. Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, and stacking depth.
D. Samples for Selection: Submit two samples of full manufacturer's color range for selection of colors.
E. Manufacturer's Instructions: Indicate special procedures.
F. Certificates: Certify that partition system meets or exceeds specified acoustic requirements.
G. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods. Describe cleaning materials detrimental to finish surfaces and hardware finish.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified this section with minimum five years of documented experience.
B. Installer Qualifications: Company specializing in performing work of this section with minimum five years of experience and certified by the operable partition manufacturer, as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.
C. Acoustical Performance: Test operable partitions in accordance with ASTM E 90 test procedure to attain no less than the STC rating specified. Provide a complete and unedited written test report by the testing laboratory upon request.
D. Preparation of Opening: Conform to ASTM E 557.
1.05 DELIVERY, STORAGE, AND HANDLING  
   A. Clearly mark packages and panels with numbering systems used on Shop Drawings. Do not use permanent markings on panels.  
   B. Protect panels during delivery, storage, and handling to comply with manufacturer’s instructions and as required to prevent damage.  

1.06 WARRANTY  
   A. Provide operable partition manufacturer’s written warranty agreeing to repair or replace components with manufacturing defects for a period of two years.  

PART 2 PRODUCTS  

2.01 MANUFACTURERS  
      1. Product: Modernfold Acoustiseal Encore, STC 52  
   B. Acceptable manufacturers pending conformance to Design Basis requirements:  
      3. Substitutions: See Section 01 60 00 - Product Requirements.  

2.02 COMPONENTS  
   A. Paired Partitions:  
      2. Panel Construction and STC Rating: Nominal 4-1/4 inch (108 mm) thick panels in manufacturer’s standard 51 inch (1295 mm) widths. All panel horizontal and vertical framing members fabricated from minimum 16 gage formed steel with overlapped and welded corners for rigidity. Top channel is reinforced to support suspension system components. Frame is designed so that full vertical edges of panels are of formed steel and provide concealed protection of the edges of the panel skin.  
         a. Panel Skin: Roll-formed steel wrapping around panel edge, with panel skins lock-formed and welded directly to the frame for unitized construction with minimum STC as follows:  
            1) STC: 52.  
         b. Hinges for Pass Doors, and Pocket Doors shall be:  
            1) SOSS Invisible laminated hinge with antifriction segments mounted between each heat treated link. Hinge attached directly to panel frame. Welded internal hinge bracket shall support the hinge and allow for adjustment of hinge plates. Concealed hinges mounted into panel edge or vertical astragal are not acceptable.  
         c. Panel Trim: No vertical trim required or allowed on vertical edges of panels; minimal groove appearance at panel joints.  
         d. Panel Weight: Steel skin.  
            1) 52 STC, 8.2 lbs./sq. ft.  
      3. Panel Finish and Exposed Trim: Factory applied as follows:  
         b. Exposed Panel Trim Color: Black.  
      4. Sound Seals and Bottom Seals:  
         a. Vertical Interlocking Sound Seals between panels: Aluminum astragal, with tongue and groove configuration in each panel edge. Rigid plastic astragals are not acceptable.  
         b. Horizontal Top Seals shall be Modernfold SureSet automatic operable top seals, manually operated operable top seals not required or permitted.  
         c. Horizontal Bottom Seals shall be Modernfold SureSet bottom seal:
1) SA4 - Automatic bottom seals providing nominal 4 inch (102 mm) operating clearance with an operating range of plus 1/2 inch (13 mm) to 3-1/2 inch (89 mm) which automatically drop as panels are positioned, without the need for tools or cranks. Extended seal exerts nominal 120 pounds (54 kg) downward force to the floor throughout operating range.

5. Suspension System:
   a. Suspension System: Modernfold No. 14 Suspension System:
      1) Track: Nominal 7 gage formed steel track with adjustable steel hanger brackets supporting the load bearing surface of the track, connected to structural support by pairs of 1/2 inch (13 mm) diameter threaded rods; no failure of track or brackets at 5,000 lb. (2268 kg) static point loading at mid-span with brackets at 48 inch (1220 mm) centers.
      2) Exposed Track Soffit: Steel, removable for service and maintenance, attached to track bracket without exposed fasteners and pre-painted off-white. Wood or aluminum soffits are not acceptable.
      3) Carriers: All-steel with four or eight steel tired ball-bearing wheels. Non-steel tires are not acceptable.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify track supports are laterally braced and will permit track to be level within 1/4 inch of required position and parallel to the floor surface.
   C. Verify floor flatness of 1/8 inch in 10 feet, non-cumulative.
   D. Verify wall plumbness of 1/8 inch in 10 feet, non-cumulative.

3.02 INSTALLATION
   A. Install partition in accordance with manufacturer's instructions and ASTM E557.
   B. Fit and align partition assembly and pocket doors level and plumb.
   C. Lubricate moving components.
   D. Apply acoustic sealant to achieve required acoustic performance.

3.03 ADJUSTING
   A. Adjust partition assembly to provide smooth operation from stacked to full open position. Do not over-compress acoustic seals.
   B. Visually inspect partition in full extended position for light leaks to identify a potential acoustical leak.
   C. Adjust partition assembly to achieve lightproof seal.

3.04 CLEANING
   A. Clean finish surfaces and partition accessories.

3.05 CLOSEOUT ACTIVITIES
   A. Demonstrate operation of partition and identify potential operational problems.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Corner guards.

1.02  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.
   C. Samples: Submit two sections of bumper rail, 24 inch long, illustrating component design, configuration, color and finish.
   D. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.03  PROJECT CONDITIONS
   A. Coordinate the work with wall or partition sections for installation of concealed blocking or anchor devices.

PART 2  PRODUCTS

2.01  MANUFACTURERS
   A. Wall and Corner Guards:
      3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  COMPONENTS
   A. Stainless Steel Corner Guards - Surface Mounted:
      1. Material: Type 304 stainless steel; 16 gauge.
      2. Size: 3-1/2 x 3-1/2 x 48 inches.
      3. Corner: 1/8 inch radius.
      4. Attachment: Stainless steel flat head screws of appropriate size, type, and spacing for attachment condition.
   B. Corner Guards - Surface Mounted: High impact vinyl with extruded aluminum full height retainer and integral impact absorbing device.
      1. Size: 2 inches.
      2. Corner: Square.
      3. Color: As selected from manufacturer's standard colors.
      4. Length: One piece.
      5. Preformed end caps.

2.03  FABRICATION
   A. Fabricate components with tight joints, corners and seams.
   B. Pre-drill holes for attachment.
   C. Form end trim closure by capping and finishing smooth.

PART 3  EXECUTION

3.01  EXAMINATION
   A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
   B. Verify that field measurements are as indicated on Drawings.

3.02  INSTALLATION
   A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.
   B. Position corner guard ____ inches above finished floor to ____ inches high.
3.03 TOLERANCES

A. Maximum Variation From Required Height: 1/4 inch.
B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Accessories for toilet rooms and utility rooms.
   B. Grab bars.

1.02 REFERENCE STANDARDS
   B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.
   C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED credits. Requirements and definitions are located in Section 01 35 15 and section 01 60 00. Submit in PDF format:
      1. Credit MR 4: Recycled content for each product, post-consumer and post-industrial. Product cost data
      2. Credit MR 5: List Products that are extracted, harvested or recovered as well as manufactured within 500 straight line miles of Project Site, or percentage of regional material by weight. Include address and distance of material source and product manufacture, product cost data.
   D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.04 COORDINATION
   A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Products listed are made by Bobrick.
   B. Other Acceptable Manufacturers:
      4. Substitutions: Section 01 60 00 - Product Requirements.
   C. All items of each type to be made by the same manufacturer.

2.02 MATERIALS
   A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
      1. Grind welded joints smooth.
      2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
   B. Keys: Provide 2 keys for each accessory to Owner; master key all lockable accessories.
   C. Stainless Steel Sheet: ASTM A666, Type 304.
   D. Stainless Steel Tubing: ASTM A269, Type 304 or 316.
E. Mirror Glass: Float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
F. Adhesive: Two component epoxy type, waterproof.
G. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof, security type.

2.03 FINISHES
A. Stainless Steel: No. 4 satin brushed finish, unless otherwise noted.

2.04 TOILET ROOM ACCESSORIES
A. Dispensers: The following items are supplied by Owner and installed by Owner:
   1. Soap Dispenser
   2. Free Standing Waste Receptacles
B. The following items are supplied by Owner and installed by Contractor
   1. Toilet Paper Dispenser
   2. Seat Cover Dispenser
C. The following items are supplied by Contractor and installed by Contractor
   1. Paper Towel Dispenser: Bobrick B-35903 Recessed Paper Towel Dispenser
   2. Hand Dryer: Dyson Airblade, AB14, color: Gray
   5. Hygiene Product Disposal: Bobrick, B-270 Surface Mounted Sanitary Napkin Disposal
   6. Baby Changing Station: Bobrick KB110-SSRE, Horizontal, Recessed Mounted Baby Changing Station
   7. Coat Hook: Bobrick, B-7671 Single Robe Hook
D. Mirrors: Supplied by Contractor and installed by Contractor Frameless, 6 mm thick float glass mirror, corners ground smooth.
   1. Hangers to be rigid, tamper and theft resistant.
   2. Backing: Full-mirror sized, minimum 0.03 inch galvanized steel sheet and nonabsorptive filler material.
E. Grab Bars: Bobrick, B-6106 Stainless steel, 1.5 inch diameter, peened grip, concealed fasteners.

2.05 UTILITY ROOM ACCESSORIES
A. Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, hat-shaped channel.
   1. Holders: 3 spring-loaded rubber cam holders.
   2. Length: 36 inches.
   3. Length: Manufacturer's standard length for number of holders.
   4. Product: __________ manufactured by __________

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify exact location of accessories for installation.
C. Verify that field measurements are as indicated on drawings.

3.02 PREPARATION
A. Deliver inserts and rough-in frames to site for timely installation.
B. Provide templates and rough-in measurements as required.
3.03 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on the drawings.
B. Install plumb and level, securely and rigidly anchored to substrate.
C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
D. Mounting Heights and Locations: As required by accessibility regulations, as indicated on drawings, and as follows:

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Fire extinguishers.
B. Fire extinguisher cabinets.
C. Accessories.

1.02  REFERENCE STANDARDS


1.03  PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10.
B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for the purpose specified and indicated.

1.04  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate cabinet physical dimensions.
C. Product Data: Provide extinguisher operational features.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.05  FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2  PRODUCTS

2.01  MANUFACTURERS

A. Fire Extinguisher Cabinets and Accessories:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
B. Dry Chemical Type Fire Extinguishers: Cast steel tank, with pressure gage.
   1. Class A:B:C.
   2. Size 10, UL Label 4A-60BC.
   3. Finish: Baked enamel, red color.

2.03  FIRE EXTINGUISHER CABINETS

A. Box Metal: Formed primed steel sheet; 0.036 inch thick base metal.
B. Cabinet Configuration: Recessed type.
   1. Sized to accommodate accessories.
   2. Trim: Stainless steel.Returned to wall surface, with 2.5 inch projection, 1.0 inch wide face.
C. Door: 0.036 inch thick stainless steel, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with continuous piano hinge. Provide nylon catch.
D. Door Glazing: Plastic, clear, 1/8 inch thick acrylic. Set in resilient channel gasket glazing.
E. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.
F. Weld, fill, and grind components smooth.
G. Finish of Cabinet Exterior Trim and Door: No. 4.
H. Finish of Cabinet Interior: White enamel.

2.04 ACCESSORIES
A. Seismic bracket for extinguisher.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Secure rigidly in place.
C. Place extinguishers in cabinets.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Metal tops and filler panels.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's published data on locker construction, sizes and accessories.
C. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.
D. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00, and other data for the following LEED credits. Requirements and definitions are located in Section 01 35 15 and section 01 60 00. Submit in PDF format:
   1. Credit MR 4: Recycled content for each product, post-consumer and post-industrial. Product cost data
   2. Credit MR 5: List Products that are extracted, harvested or recovered as well as manufactured within 500 straight line miles of Project Site, or percentage of regional material by weight. Include address and distance of material source and product manufacture, product cost data.
E. Manufacturer's Installation Instructions: Indicate component installation assembly.

1.03 MOCK-UP
A. Provide mock-up of one full size locker, single tier with sloped top, in selected colors.
B. Locate where directed.
C. Mock-up may remain as part of the Work.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 LOCKER APPLICATIONS
A. Student Lockers: Single tier solid plastic (HDPE) lockers, recessed mounted.
   1. Width: 9 inches.
   2. Depth: 12 inches.
   3. Height: 72 inches.
   4. Fittings: Hat shelf, 2 coat hooks.

2.03 MATERIALS
A. Sheet Steel: ASTM A653/A653M SS Grade 33/230, with G60/Z180 coating, stretcher leveled; to the following minimum thicknesses:
   1. Body and Shelf: 24 gage, 0.024 inch.
   2. Door Outer Face: 18 gage, 0.048 inch.
   3. Door Inner Face: 20 gage, 0.036 inch.
   4. Door Frame: 16 gage, 0.060 inch.
   5. Hinges: 14 gage, 0.075 inch.
   6. Base: 20 gage, 0.036 inch.
   7. Sloping Top: 20 gage, 0.036 inch.
   8. Trim: 20 gage, 0.036 inch.
B. Accessories For Each Locker: Two single prong wall hooks, coat hanger bar.

2.04 LOCKER UNITS
A. Width: 12 inches.
B. Depth: 12 inches.
C. Height: 72 inches.
D. Configuration: single tier.
E. Mounting: Recessed.
F. Base: Metal base.
   1. Base Height: 4 inch.
G. Locking: Equipped for combination locks.
H. Ventilation Method: Door louvers.
I. Class: Conventional.
J. Locker Body: Formed and flanged; with steel stiffener ribs; electric spot welded.
K. Frames: Formed channel shape, welded and ground flush, welded to body, resilient gaskets and latching for quiet operation.
L. Doors: Hollow double pan, sandwich construction with acoustic insulation fill, 1-3/16 inch thick; welded construction, channel reinforced top and bottom with intermediate stiffener ribs, grind and finish edges smooth.
M. Hinges: Two for doors under 42 inches high; three for doors over 42 inches high; weld securely to locker body and door.
N. Integral Cylinder Lock: ________ type, master keyed; provide two keys per lock and four master keys.
O. Number Plates: Provide oval shaped brass plates. Form numbers ____ inch high of block font style with ADA designation, in contrasting color.
P. Provide ventilation openings at top and bottom of each locker.
Q. Form recess for operating handle and locking device.
R. Finish edges smooth without burrs.

2.05 FINISHING
A. Clean, degrease, and neutralize metal; prime and finish with one coat of baked enamel.
B. Paint locker bodies and doors in contrasting colors.
C. Paint locker units 1 color, as selected.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that prepared bases are in correct position and configuration.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install lockers plumb and square.
C. Place and secure on prepared base.

3.03 CLEANING
A. Clean locker interiors and exterior surfaces.

END OF SECTION
PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Shelf standards, brackets, and accessories.
   B. Closet rods for mounting on brackets.
   C. Shelves.
   D. See drawings for locations and configurations.

1.02  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used.

1.03  DELIVERY, STORAGE, AND HANDLING
   A. Store products under cover and elevated above grade.
   B. Store products in manufacturer's unopened packaging until ready for installation.

PART 2  PRODUCTS
2.01  MANUFACTURERS
   A. Shelf Standards and Brackets:

2.02  MATERIALS
   A. Extra Heavy Duty Shelf Standards: Single-slotted channel standards for brackets adjustable in
      1 inch increments along entire length of standard, drilled and countersunk for screws.
      1. Load Capacity: Recommended by manufacturer for loading of 540 to 1,060 pounds per
         pair of standards.
      3. Brackets: 12 gage 0.105 inches steel, reinforced, locking into slots with molded nylon
         cam lock lever; size to suit shelves; same finish as standards.
      4. Bracket Quantity: Provide one bracket for each 12 inches of standard length.
   B. Closet Rods: Steel tubing for wall mounting in flange fittings.
      1. Length: As required for application, up to 12 feet.
      2. Provide mounting fittings to suit application.
   C. Fasteners: Screws as recommended by manufacturer for intended application or as otherwise
      required by project conditions.

PART 3  EXECUTION
3.01  EXAMINATION
   A. Do not begin installation until substrates have been properly prepared.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory
      preparation before proceeding.

3.02  PREPARATION
   A. Clean surfaces thoroughly prior to installation.
   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best
      result for the substrate under the project conditions.

3.03  INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Mount standards to solid backing capable of supporting intended loads.
   C. Install brackets, shelving, and accessories.

3.04  PROTECTION
   A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY
   A. Section includes interior wall-mounted steel bicycle racks; attachments for wall mounting.

1.02 SUBMITTALS
   A. Product Data: Include installation instructions.
   B. Samples: Standard color samples.
   C. Warranty: Manufacturer's standard warranty.

1.03 DELIVERY, STORAGE, AND HANDLING
   A. Handling: Protect materials and finish from damage during handling and installation.

PART 2 - PRODUCTS

2.01 MANUFACTURER
   A. Acceptable Manufacturers:
      D. Substitutions: Comply with Section 01 60 00 - Product Requirements.

2.02 MATERIALS
   A. Pipe: ASTM A 53, Schedule 40 or Schedule 10.
   B. Tubing: ASTM A 500.
   C. Round Bar and Flat Bar: ASTM A 36.

2.03 STEEL BICYCLE RACKS
      1. Bicycle Capacity: Accommodate single or shared usage.
      2. Mounting: Surface wall mounted; Stagger rack height to maximize spacing.
      3. Finish: Thermally fused TGIC polyester powder.
   B. Delta Cycle, Leonardo bicycle storage hook.
      3. Finish: Thermally fused TGIC polyester powder.
         a. Color: Silver powdercoat finish

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Examine surfaces to receive bicycle racks. Notify Architect of conditions that would adversely affect installation or subsequent utilization of bicycle racks. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION
   A. Install bicycle racks in accordance with manufacturer's instructions at locations indicated on the drawings.
   B. Install bicycle racks level, plumb, square, accurately aligned, correctly located, and without warp.
   C. Permanent Surface Mounting: Anchor bicycle racks securely in place to structure in accordance with manufacturer's instructions.
   D. Use hardware and fasteners in accordance with manufacturer's instructions.
   E. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.
F. Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.03 CLEANING
A. Clean bicycle racks in accordance with manufacturer's instructions.
B. Remove temporary protective coverings.
C. Do not use harsh cleaning materials or methods that would damage finish.

3.04 PROTECTION
A. Protect installed bicycle racks from damage during construction.

END OF SECTION
1.01 SECTION INCLUDES
   A. Aluminum Flagpoles.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data on pole, accessories, and configurations.
   C. Shop Drawings: Indicate detailed dimensions, base details, anchor requirements, and imposed loads.
   D. Samples: Submit two __________, ____ by ____ inch in size, illustrating pole material, color, and finish.
   E. Operation Data: Provide operating data for the controller and timer.
   F. Maintenance Data: Provide lubrication and periodic maintenance requirement schedules and __________.

1.04 QUALITY ASSURANCE
   A. Designer Qualifications: Design flagpole foundation under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed the State in which the Project is located.
   B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Spiral wrap flagpole with protective covering and pack in protective shipping tubes or containers.
   B. Protect flagpole and accessories from damage or moisture.

PART 2 PRODUCTS

2.01 FLAGPOLES
   A. Flagpoles: Aluminum.
      1. Design: Straight shaft.
      2. Mounting: Ground mounted type.
      3. Outside Butt Diameter: ____ inches.
      5. Nominal Wall Thickness: ____ inches.
      6. Nominal Height: ____ ft; measured from nominal ground elevation.
      7. Halyard: Interior type, electric operation.
   B. Performance Requirements:
      1. Flagpole With Flag Flying: Resistant without permanent deformation to ____ miles/hr wind velocity; non-resonant, safety design factor of 2.5.
      2. Flagpole Without Flag: Resistant without permanent deformation to ____ miles/hr wind velocity; non-resonant, safety design factor of 2.5.

2.02 ACCESSORIES
   A. Finial Ball: Stainless steel, 6 inch diameter.
   B. Cleats: 9 inch size, aluminum with galvanized steel fastenings, two per halyard.
   C. Cleat Box: Aluminum, with built-in hinge and hasp assembly, attached to pole with tamper proof screws inside box.
   D. Halyard: 5/16 inch diameter polypropylene, braided, white.
2.03 OPERATORS  
   A. Hand Crank: Removable ______ type.

2.04 MOUNTING COMPONENTS  
   A. Foundation Tube Sleeve: AASHTO M 36M, corrugated 16 gage steel, galvanized, depth of ____ inches, as indicated.  
   B. Pole Base Attachment: Flush; steel base with base cover.

PART 3 EXECUTION

3.01 EXAMINATION  
   A. Verify that concrete foundation is ready to receive work and dimensions are as indicated on shop drawings.  
   B. Verify that electric power is available and of the correct characteristics.

3.02 PREPARATION  
   A. Coat metal sleeve surfaces below grade and surfaces in contact with dissimilar materials with asphaltic paint.

3.03 INSTALLATION  
   A. Install flagpole, base assembly, and fittings in accordance with manufacturer's instructions.  

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES:
A. Curtains for Multi-Functional Auditorium.
B. Curtain Track and Hardware.

1.02 RELATED SECTIONS:
A. Section 05 50 00 - Metal Fabrications - Miscellaneous Metal Supports

1.03 SCOPE
A. All materials, components, and services necessary to provide a complete system indicated in this Section, as specified herein and shown on related Drawings, including:
   1. Preparation and submission of complete shop drawings and samples for review prior to fabrication.
   2. Verification of dimensions and conditions at the job site.
   3. Shipment of equipment to job site and the secured storage of all non-fixed equipment.
   4. Installation and completion, in accordance with these Specifications, related Drawings, the Equipment Manufacturer's recommendations, established trade criteria, and all applicable code requirements.
   5. The inspection, demonstration, and necessary adjustment of the completed installation by the Contractor's engineering personnel.
   6. Preparation and submission of complete record drawings and operational and maintenance data and certificates.

1.04 SUBMITTALS:
A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. With bid.
   1. Proof that the firm has been continuously engaged in the fabrication and installation of stage rigging and drapery for professional theatres during the past five (5) consecutive years.
   2. A list of at least three (3) professional theatre stage rigging and drapery installations by the bidder comparable to this project in scope.
   3. A list of any proposed deviations or exceptions from the Specifications. Any deviations or exceptions from the Specification proposed after bid shall not be accepted.
   4. A schedule for the anticipated completion of the following:
      a. Shop drawings
      b. Delivery of all equipment
      c. Installation of all systems
C. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00 and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and 01 60 00.
   1. Credit MR 4: Recycled Content for each product, post-consumer and post-industrial and cost of material, excluding cost of labor and equipment for installation.
   2. Credit MR 5: List products that are extracted/harvested or recovered as well as manufactured within 500 straight line miles of Project Site or percent of regional material by weight. Include address and distance of material source and product manufacture, cost of materials excluding cost of labor and equipment for installation.
D. Product Data: Provide data indicating physical and dimensional characteristics and operating procedures.
E. Certification: Provide manufacturer's certification that stage curtains comply with requirements for flame resistance.
F. Shop Drawings: Submit one set of editable PDF file drawings indicating layout and equipment.
G. Samples: 36 inch long sample of each type of curtain track, complete with (if applicable) one single carrier, and one master carrier.
H. Manufacturer's Installation Instructions: Indicate special procedures.

1.05 QUALITY ASSURANCE:
A. All equipment and installation shall be the responsibility of a single contractor who shall own and operate a full-time, staffed shop for the fabrication and assembly of stage equipment. This Contractor shall assume complete responsibility for the engineering, fabrication, transportation, and installation of the work in this Section, and shall hold the Owner, Architect, Theatre Consultant, and all their Employees and Consultants harmless for any costs for errors and omissions associated with the work of this Section and any action arising therefrom.

B. Contractors not having a qualified and experienced sewing room as an integral part of their operation shall employ the services of a qualified and experienced Sewing Sub-contractor for the fabrication of stage curtains. Sewing Sub-contractor shall have at least ten (10) years experience in the fabrication of curtains for professional theatres. If requested, the Rigging Contractor shall submit a representative list of professional theatre projects performed by the Sewing Sub-contractor during the above period. Subject to the above requirements, work performed under this Section may be by one of the following Sewing Sub-contractors:
   1. Rose Brand, New York, New York
   2. Stage Decoration and Supplies, Greensboro, North Carolina
   3. Stagecraft Industries, Portland, Oregon
   4. Syracuse Scenery and Stage Lighting, Liverpool, New York
   5. Tiffin Scenic Co., Tiffin, Ohio
   6. Tru-Roll Inc., Glendale, California
   7. I. Weiss & Sons, Long Island City, New York

1.06 GENERAL REQUIREMENTS
A. Warranty
   1. The Contractor shall unconditionally warrant all equipment and systems provided under this Section to be free from defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance of all work of this Section.
   2. All repairs and service during the warranty period shall be performed at the job site; labor, materials, and transportation of replacement material and parts and service personnel to and from the job site shall be included hereunder at the Contractor's expense.
   3. Appropriate additional equipment or draperies to replace equipment, devices, or draperies removed for repair, service, or cleaning shall be provided at the job site at no expense to the Owner to replace any and all equipment which must be removed for repair or service.
   4. Warranty service shall be performed by personnel in the employ of the Contractor and shall not be sub-contracted or assigned to another company, service, or individual unless the Owner has approved such assignment in writing, in which event the Contractor shall nevertheless be responsible to the Owner for such work.

PART 2 PRODUCTS
2.01 GENERAL
A. All components shall be new and of first quality.
B. Machinery and component parts shall comply with applicable trade practice, industry standards, and code requirements and bear appropriate labels of conformity and acceptability.
C. All flameproofed components shall bear pertinent flameproofing certificates and UL labels. All components shall bear labels identifying the manufacturer, model number, and serial number. All such labels and certificates shall be permanently attached in a conspicuous location.
D. Operating parts of all equipment shall be machine finished, and tolerances, finishes, fit, etc., where not specified, shall conform to good trade practices.

2.02 DESIGN RESPONSIBILITY
A. Provide all supplementary structural support necessary for safe and proper static and dynamic conditions of all systems and components required for the work of the Specification. Supplementary structural support required for access, support, enclosure, and service to all
motors and motor control cabinets shall be supplied and installed as part of the work of this Section. All attachments, anchorages, connections, and miscellaneous steel additions to accommodate pulleys, blocks, etc., shall be designed supplied, and installed by the Contractor and reviewed by the Architect. All methods of connection and imposed loads resulting from the Contractor's work shall be submitted to the Architect prior to fabrication.

2.03 MANUFACTURER'S
A. Stage Curtains
  1. Stagecraft Industries Inc. www.stagecraftindustries.com
     a. Products: Subject to compliance with requirements, provide one of the following heavy weight velour fabrics:
        1) "Symphony"; Dazians, Inc.
        2) "Memorable", K&M Fabrics, Inc.
        3) "Overture", JB Martin, Inc.
        4) "Wilson", Melfabco, Inc.
        5) "Dante", DesignTex.
  2. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 PRODUCTS:
A. Materials:
  1. Curtain Fabric:
     a. Woven Cotton Velour: Napped fabric of 100% cotton; 54" width minimum; not less than 40 backing ends per inch, 40 pile ends per inch, and 32 picks per inch; 640 pile tufts per square inch; other characteristics as follows:
        b. Heavy Weight: Fabric weighing not less than 23 ounces per linear yard before flameproofing, with pile height of approximately 125 mils.
        c. Lining: Denim cloth of 100% cotton, 54" minimum width.
        d. Color: To be selected by Architect from Manufacturer's complete color palette.
        e. Flame resistance: as required by NFPA 701
           1) Permanently attach labels to each curtain indicating whether curtain is permanently and inherently flame resistant, or whether it will require retreatment after dry cleaning.
  2. Curtains:
     a. General: Provide not less than 50% additional fullness for curtains, unless otherwise indicated. Horizontal seams and fabric less than half-width are not permitted.
        1) Vertical Hems: Provide vertical hems not less than 2" wide, double-stitched and machine-sewn with no salvage material visible from front of curtain.
        2) Turnbacks: At all leading edge(s) or curtain panels, provide turnbacks, formed by folding 12" of face fabric back at leading edge of panels and securing by sewing across top hem and grommeting through both layers of fabric.
        3) Top hems: Reinforce top hems by double-stitching 3-l/2" wide heavy jute webbing to top edge with minimum 1" of face fabric turned under.
        4) Pleats: Provide fullness in curtains by sewing 6" of additional material into box pleats spaced at 12" centers along top hem reinforcing. Provide not less than #2 brass grommets spaced at 12" and centered on box pleats, for tie lines or "S" hooks.
        5) Bottom Hems: Except for curtains which hang to floor, provide bottom hems not less than 3" deep. For floor-length curtains, provide 5" hems with separate interior heavy canvas chain pockets equipped No. 8 jack chain. Stitch chain pocket so chain rides 2" above bottom edge of curtain.
        6) Lining: Provide lining in same fullness as face fabric, and finished 2" shorter than face fabric. Unless otherwise specified, provide lining constructed of same fiber type as face fabric. Attach lining to face fabric along bottom line at seams with 4" long strips of heavy woven cotton tape.
  3. Metal Products:
STAGE CURTAINS

a. Steel Tube: 16 gauge; 1 ½” unless otherwise indicated. Paint with a flat, rust-inhibitive primer and finish coat paint.
b. Steel Pipe: Schedule 40 1 ½” unless otherwise indicated. Paint with a flat, rust-inhibitive primer and finish coat paint.
c. Support Chain / Aircraft Cable: Chain or aircraft cable of adequate size to support loads. Provide means for adjustment on all suspension points.
d. Inserts, Bolts and Fasteners: Manufacturer's standard units, unless otherwise indicated.

4. Walk-Along Cyclorama Track: Standard duty clamp type, walk along track.
   a. Basis of Design: H&H Specialties Inc. Series Product 300-WB.
   b. Shop-finished black.
   c. Dimensions and radius per Drawings.

5. Track Switching Devices:

2.05 PIPE BATTENS
   A. Pipe battens shall be nominal 1 1/2 inch I.D. black steel pipe, ASTM A53/A Strong (Schedule 40), stripped and painted with at least one coat of black primer and one coat of flat black paint.
   B. Splices shall be close-fitting internal steel sleeves with a wall thickness of not less than 0.1875 inch, and min. 24 inches long. One side of the splice shall be held in place with a minimum of two (2) plug welds. Other side shall be held with a minimum of two (2) 5/16 inch bolts and lock nuts; bolts shall be placed at right angles.

2.06 TRACKS
   A. All curtains shall be hung at center of trim chain length, to permit trim adjustment.
   B. All tracks shall be provided with rear fold devices to stack curtain only at offstage track ends. Rubber washers shall be placed on both sides of each rear fold tab.

2.07 WALK-DRAW TRACKS
   A. Each track shall be one continuous piece, except where splicing clamps are required. Splicing clamps shall provide a flush, positive alignment of track sections.
   B. All curtains shall be hung at center of trim chain length, to permit trim adjustment.
   C. All track channel shall be anodized flat black. All hangers and carriers shall be painted flat black.
   D. Provide and install tow ropes for each end of each curtain panel. Tow ropes shall be 3/8 inch braided cotton rope with 2 inch diameter wood balls on the operating end, 4 ft 0 in above stage level. Ropes and handles shall be black.

2.08 CURTAINS
   A. Fabrics
      1. All fabrics not inherently flameproof shall be fully mill flameproofed by the immersion process to meet or exceed the minimum requirements set forth by NFPA "Small Scale 701." The Contractor shall submit certificates so stating.
      2. All fabrics shall be produced from one dye lot per color. Color quality shall be consistent throughout, with no visible streaking, striping, or spotting.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine area and conditions for compliance with requirements for supporting members, blocking, clearances, and other conditions affecting performance of stage curtain work. Proceed with installation only after unsatisfactory conditions have been corrected.
3.02 PREPARATION
   A. Verify inserts, clips and other supports required to be installed by other trades for support of tracks and battens have been installed and meet manufacturers requirements.

3.03 FABRICATION
   A. This Contractor is responsible for becoming familiar with and verifying all pertinent dimensions and conditions, both in the Drawings and in the field, before proceeding with any work.
   B. Coordinate the design, planning, and scheduling of the work of this Section with the work of all other trades. Notify the Architect of any difficulties in coordinating work with other contractors. Failure to do so shall constitute acceptance of construction as suitable in all ways to receive the work of this Section.
   C. All metal fabricated items shall be given at least one coat of primer and one coat of finish paint. Color: flat black.
   D. Where not specifically called out in the Drawings and Specifications, tracks and fittings shall be painted or anodized black.
   E. Verify curtain height dimensions after track installation is complete, prior to fabricating curtains.
   F. All equipment shall be fabricated and installed to facilitate maintenance and future replacement.

3.04 INSTALLATION
   A. Contractor shall employ only experienced stage riggers for the installation of work of this Section.
   B. Coordinate installation with all other trades doing adjoining work.
   C. Examine all existing conditions at the jobsite prior to beginning installation.
   D. Provide protection for all stage flooring, regardless of whether flooring has been stained or sealed. Flooring shall be protected from both structural damage and cosmetic damage.
   E. Provide and install all supplementary structural support as required for the installation and safe operation of equipment and materials supplied under this section.
   F. No curtains shall be installed until construction and painting are complete and the building has been cleaned. Any curtains delivered to the job site prior to their installation shall be stored in a clean area in dustproof bags.
   G. General:
      1. Install materials in accordance with manufacturer's printed instructions and recommendations. Comply with governing regulations.
   H. Curtains:
      1. Track-Hung: Secure curtains to track carriers with track manufacturer's special heavy-duty "S" hooks or snap hooks

3.05 SCHEDULE
   A. AC-1
      1. Location: Multifunctional Auditorium
      2. Manufacturer: KM Fabrics, Inc.
      3. Product: Charisma 23.5 - 24.5 oz. 100% IFR Polyester
      4. Size: 54 inch wide
      5. Color: 1060 Pewter
      6. Quantity: Nine (9) panels of 20 ft. 0 in. deployed length.
   B. Drapery Tack
      1. Location: Multifunctional Auditorium
      2. Manufacturer: H & H Specialties

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES:
A. Pipe Grid for Multifunctional Auditorium.

1.02 RELATED SECTIONS:
A. Section 09 21 16 - Gypsum Board Assemblies - Ceiling Isolation Clips.
B. Section 05 50 00 - Metal Fabrications - Miscellaneous Metal Supports

1.03 SUBMITTALS:
A. Product Data: Submit manufacturer's specifications, installation instructions and general recommendations, including data which substantiates that materials comply with requirements.
B. LEED Submittals: Complete LEED Checklist and Tracking Form, Section 01 33 00 and other data for the following LEED Credits. Requirements and definitions are located in Section 01 35 15 and 01 60 00.
   1. Credit MR 4: Recycled Content for each product, post-consumer and post-industrial and cost of material, excluding cost of labor and equipment for installation.
   2. Credit MR 5: List products that are extracted/harvested or recovered as well as manufactured within 500 straight line miles of Project Site or percent of regional material by weight. Include address and distance of material source and product manufacture, cost of materials excluding cost of labor and equipment for installation.
C. Product Data: Provide data indicating physical and dimensional characteristics and operating procedures.
D. Shop Drawings: Submit shop drawings, including plans, elevations, and detail sections of grid plan and layout. Show all attachments to structure, anchor loads, hardware and components of grid system. Show layouts for inserts, clips and other supports required to be installed by other trades for support of tracks and battens.
E. Manufacturer's Installation Instructions: Indicate special procedures.

1.04 QUALITY ASSURANCE:
A. Fabricator/Installer Qualifications: Firm with not less than five years of experience in fabrication and installation of studio grid systems similar to that required for this project.

PART 2 PRODUCTS

2.01 MANUFACTURER'S
A. Studio Pipe Grid
   1. Stagecraft Industries Inc. www.stagecraftindustries.com
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PRODUCTS
A. Pipe: 1½” Schedule 40 black iron pipe, painted flat black. Provide Internal sleeve splicing where required. Form approximately 8'-0" x 8'-0" grid openings.
B. Cross Connect Clamps: Formed steel with U-bolt connections. Provide at each intersection of pipe.
C. Grid Hangers: Provide quantity, type and extent as required by manufacturer. Provide 60 durometer waffle pads at each point to prevent vibration transmission between building structure and studio grid at each connection.

PART 3 EXECUTION

3.01 EXAMINATION
A. The contractor shall examine the areas and conditions under which the equipment shall be installed and shall notify the General contractor in writing of conditions detrimental to the proper and timely completion of work.
3.02 COORDINATION:
   A. Consult and coordinate with electrical and metal framing contractors to locate hanging
      hardware, attachment points and sequence of installation at ceiling area.

3.03 INSTALLATION
   A. Install pipe grid level and plumb to studio floor at an elevation indicated on drawings.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Work of this Section includes design, supply and installation of maintenance equipment for roof and wall mounted fall restraint safety anchors,
   1. Wall mounted safety anchors.
   2. Horizontal cable lifeline system.
   3. Horizontal trolley rail lifeline system.

1.02 REFERENCES

B. AISI SG-971-1996, with 2000 Supplement “Specification for Design of Cold-Formed Steel Structural Members”.
F. ASME A120.1-2000, Safety requirements for Powered Platforms for Building Maintenance.

1.03 REQUIREMENTS

A. Design window cleaning/suspended maintenance system to suit building and in accordance with plans, specifications, standards, and regulations/codes contained in section 1.04 and 1.08.
B. Locate davit bases to suit suspension equipment which will be used on the building with respect to items such as reach, rigging, spacing, roof edge condition and similar items.
C. Confirm all anchor components will provide adequate attachment to the building and are suited to current suspended maintenance practices. Confirm compatibility with industry standard equipment.
D. Ensure all anchor components conform to proper engineering principles and conform to the requirements of window cleaning/suspended maintenance equipment, its application and safety requirements.
E. Design system fall arrest safety anchors and equipment supports to comply with all governing code requirements.
F. Design system fall arrest safety anchors and equipment supports to comply with the following structural requirements:
   1. Fall Arrest Safety Anchors: designed to a maximum fall arresting force of typically 1800 lbs (8.0 kN) when wearing a body harness with a safety factor of 2 without any permanent deformation and to 5000 lbs (22.24 kN) against fracture or detachment.
   2. Ensure design of primary support equipment is capable of sustaining without failure at least four times the maximum static working load applied or transmitted to the components, i.e. a 4 to 1 stability factor.
   3. Supports for Suspended Platforms: davits, rigging sleeves and monorails are used for suspending a powered platform from storage and rigging/working locations on the building. These supports and the structure to which they are attached are typically designed to 1000 lbs (4.45 kN) vertical service load plus impact with a factor of safety as per AISC requirements and/or ACI or other applicable construction codes, and to 4 times the rated load against fracture or detachment (i.e. a 4 to 1 stability factor).

1.04 SUBMITTALS

A. Product Data.
B. Submit shop drawings showing complete layout and configuration of complete suspended maintenance system, including all components and accessories. Clearly indicate design loads and fabrication details, hardware, and installation details.

C. Shop drawings to include installation and rigging instructions and all necessary Restrictive and Non-Restrictive Working Usage Notes and General Safety Notes.

D. Shop drawings to be reviewed, signed, and stamped by a professional engineer, and upon request, complete with calculations or test reports.

E. Delegated Design Procedures: Comply with Section 01 33 16.

F. Manufacturer’s Qualifications: Experience and proof of insurance.

G. Welder’s certificates.

H. Sample Warranty.

1.05 QUALIFICATIONS

A. Manufacturer’s Qualification: Manufacturer specializing in the design, fabrication and installation of window cleaning/suspended maintenance systems having a minimum of 5 years documented experience.

B. Loading and Safety Assurance: Comply with regulations of Project jurisdiction for engineered loading and safety criteria for the intended use.

C. Insurance: Manufacturer to carry specific liability insurance (products and completed operations) in the amount of $2,000,000.00 to protect against product/system failure.

D. Welding shall be executed by welders certified in accordance with AWS requirements.

1.06 REGULATORY REQUIREMENTS

A. Comply with the following OSHA regulations:
   1. 1910, Subpart D (Walking and Working Surfaces).
   3. "OSHA Ruling on Window Cleaning by Bosun's Chair" Memorandum to Regional Administrators from P.K. Clark, Director, Directorate of Compliance Programs.
   4. 1910.33, Subpart F (Powered Platforms).

B. Comply with the following California State regulation:
   1. Code of Regulations, Title 8-Industrial Relations:
      a. Article 5 (Window cleaning).
      b. Article 6 (Powered Platforms for Exterior Building Maintenance).
      c. Appendix C to Article 6 (Personal Fall Arrest System).

1.07 MAINTENANCE DATA

A. Submit 1 copy of system Equipment Manual & Inspection Log Book, with “Initial Inspection Certification for Use” and “Inspection Sign-Off” forms completed.

B. Submit 2 copies of a reduced plastic laminated as-built shop drawing showing equipment locations and details. This drawing is to be posted near exits onto the roof.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Manufactured products meeting this specification may be submitted for approval provided that manufacturers show proof of product insurance.
   1. Submit Equipment details to be approved by the Owner.

2.02 SAFETY SYSTEMS AND ANCHORS

A. New Construction:
   1. Cast-In-Place: Capable of withstanding 5000 lbs. (2272.2 kg) in any direction without fracture or detachment. Capable of withstanding 2500 lbs. (1136.1 kg) in any direction without permanent deflection. Cast-in-place Rooftop Anchor consists of six major components:
FALL PROTECTION SYSTEM

1. Cap is 1\ 4 inch (6 mm) ASTM A 36, structural quality carbon steel plate.
2. Base plate is 5/8 inch (16 mm) ASTM A 36, structural quality carbon steel with 1 threaded stainless steel bolt and washers.
3. Upright hollow structural section is 3-1/2 to 4-1/2 inches (89 to 114 mm) Schedule 40 carbon steel, ASTM A 500, Grade B. Polyurethane foam filled (optional).
4. Loop is 3/4 inch (19 mm) 304 stainless round bar, ASTM A 182.
5. Carbon steel components hot dip galvanized after fabrication or coated with LINE-X Protective Coatings, XS-100 or XS-350.

f. Flashing compatible with roof membrane.

2. Weld to Structure: Capable of withstanding 5000 lbs. (2272.2 kg) in any direction without fracture or detachment. Capable of withstanding 2500 lbs. (1136.1 kg) in any direction without permanent deflection. Weld to Structure rooftop anchor consists of five major components:

a. Cap is 1/4 inch (6 mm) ASTM A 36, structural quality carbon steel plate.

b. Upright hollow structural section is 3-1/2 to 4-1/2 inches (89 to 114 mm) Schedule 40 carbon steel, ASTM A 500, Grade B. Polyurethane foam filled (optional).

c. Loop is 3/4 inch (19 mm) 304 stainless round bar, ASTM A 182.

d. Carbon steel components hot dip galvanized after fabrication or coated with LINE-X Protective Coatings, XS-100 or XS-350.

e. Flashing compatible with roof membrane.

3. Open web steel joist rooftop anchor consists of seven major components:

a. Cap is 1/4 inch (6 mm) ASTM A 36, structural quality carbon steel plate.

b. Base plate and bottom plate is 5/8 inch (16 mm) ASTM A 36, structural quality carbon steel with 4 threaded hot dip galvanized steel bolts and standard hex nuts and lock washers.

c. Upright hollow structural section is 3-1/2 to 4-1/2 inches (89 to 114 mm) Schedule 40 carbon steel, ASTM A 500, Grade B. Polyurethane foam filled (optional).

d. Loop is 3/4 inch (19 mm) 304 stainless round bar, ASTM A 182.

e. Tube 2 by 4 inch: Material is 2 inch by 4 inch by 3/16 inch (51 mm by 102 mm by 5 mm) Carbon Steel, ASTM A 500, Grade B.

f. Carbon steel components hot dip galvanized after fabrication or coated with LINE-X Protective Coatings, XS-100 or XS-350.

g. Flashing compatible with roof membrane.

4. Bolt Through: Capable of withstanding 5000 lbs. (2272.2 kg) in any direction without fracture or detachment. Capable of withstanding 2500 lbs. (1136.1 kg) in any direction without permanent deflection. Bolt through rooftop anchor consists of five major components:

a. Cap is 1/4 inch (6 mm) ASTM A 36, structural quality carbon steel plate with 1 5/8 inch threaded hot dip galvanized steel bolt.

b. Upright hollow structural section is 3-1/2 to 4-1/2 inches (89 to 114 mm) Schedule 40 carbon steel, ASTM A 500, Grade B. Polyurethane foam filled (optional).

c. Loop is 3/4 inch (19 mm) 304 stainless round bar, ASTM A 182.

d. Carbon steel components hot dip galvanized after fabrication or coated with LINE-X Protective Coatings, XS-100 or XS-350.

e. Flashing compatible with roof membrane.

5. RoofSafe Force Management Anchor: Rooftop Force Management anchors must be designed to withstand a factor of two times the maximum arresting force, but is designed to deform in the event of a fall arrest situation or overloading. When used as a single point anchor, the eye can be set to rotate 360 degrees. Rooftop Anchor consists of four major components:

a. The Stainless Steel "eye"

b. Force Management Anchor

c. Four zinc coat heavy duty steel toggle bolts, S-5! Clamps or heavy duty rivets (dependent upon the attachment surface).
d. RoofSafe Anchors are aluminum with a powder coat finish, PVC coated, or have an spun aluminum shroud.

2.03 SAFETY AND TIEBACK ANCHORS

A. Safety U-bars: Mild steel, Type 300W with yield strength of 44 Ksi (300 MPa), hot dipped galvanized to ASTM A123/A 123M. U-bar to be not less than 3/4" (19 mm) diameter material with 1-1/2" (38 mm) eye opening.

B. Safety Anchor Eye Plate: Mild steel, Type 300W with yield strength of 44 Ksi (300 MPa), hot-dip galvanized to ASTM A123/A 123M. Plate to be not less than 7/8" (22 mm) thickness material with 2" (50 mm) eye opening having chamfered edges.

C. Securement Bolts: mild steel, Type 300W with yield strength of 44 Ksi (300 MPa), hot-dip galvanized to ASTM A123/A 123M-2000.

D. Hollow Steel Section (HSS) Piers: Mild steel, Type 300W with yield strength of 50 Ksi (350 MPa). Wall thickness to suit application, hot dipped galvanized to ASTM A123/A 123M-2000.

E. Base Plate and All Other Sections: galvanized mild steel as above with yield strength of 44 Ksi (300 MPa). Thickness and securement to suit application.

F. Seamless Spun Aluminum Flashing (for steel pier anchors): Type 6061-T6 alloy to ASTM B221-2000 with deck flange flashed in to NRCA recommendations. Seal top of aluminum flashing with detachable watertight stainless steel cap.

G. Miscellaneous Bolts, Nuts and Washers: mild steel, Type 300W with yield strength of 44 Ksi (300 Mpa), hot-dip galvanized to ASTM A123/A 123M-2000, or Type 304 stainless steel with yield strength of 35 Ksi (240 Mpa).

2.04 DOUBLE LANYARD (DL) HORIZONTAL CABLE LIFELINE SYSTEM

A. Cable: 5/16" (8 mm) diameter stainless steel with minimum breaking strength of 19,125 lbs. (85 kN), complete with matching permanently swedged or mechanically swedged cable ends.

B. Data Plate: Cable system entry points to be equipped with prominently displayed non-corrosive data plate clearly stating Maximum Service Capacity and Number of Users.

C. Tensioner: steel turnbuckle, same material as cable.

D. Harness: manufacturer's standard full body harness with double lanyard and shock absorbers.

E. Tethers: All pins and loose pieces to be secured using 1/8" (3 mm) stainless steel cable complete with easily inserted lead connectors to avoid loss.

F. Plate and all other sections: Galvanized steel as per safety anchor with yield strength of 44 Ksi (300 MPa).

G. Seamless spun aluminum flashing (for fall restraint safety anchors bases): Type 6061-T6 alloy to ASTM B221-2000 sized with deck flange flashed in to NRCA or CRCA recommendations. Seal top of aluminum flashing with conformable mastic tape and torch applied heat-shrink rubber collar flashing.

H. Miscellaneous bolts, nuts and washers: mild steel, Type 300W with yield strength of 44 Ksi (300 MPa), hot-dip galvanized to ASTM A123/A 123M-2000 or Type 304 stainless steel with yield strength of 35 Ksi (240 MPa).

2.05 ROOFTOP RAIL SYSTEMS

A. Horizontal Rigid Rail System:

1. UniRail System is an extruded aluminum rail system that provides a simple continuous anchor for a free flowing carriage device to travel past joints, intermediate support brackets and around corners

2. Multi-span horizontal rail system that provides uninterrupted pass through capabilities at any mid span points and continuous hands free operation.

3. Designed for at least 2 simultaneous users.

4. Provide plunger type end stops to facilitate the removal and replacement of carriages.

5. All attachment brackets, anchors and joint splices are 316 stainless steel.
6. 6082 T6 aluminum rail.
7. Rail sections must “float” in the attachment brackets so as to mitigate the effects of thermal expansion and contraction.
8. User(s) can bypass the intermediate bracket and rail joints.
9. Loads imposed on the system joints and intermediate supports are calculated for each installation assuming the worst case scenario to insure the anchorage strength meets the calculated loads as required by OSHA.
10. Manufacturer and or certified installer to submit loading calculations and performance data for UniRail fall protection system as well as fall clearance calculations reviewed and stamped by a professional engineer licensed in the state where the system will be located.

Quantity of free flowing carriages - 2

2.06 FABRICATION
   A. Fabricate work true to dimension, square, plumb, level and free from distortion or defects detrimental to appearance and performance.
   B. Grind off surplus welding material and ensure exposed internal and external corners have smooth lines.

PART 3 - EXECUTION
3.01 EXAMINATION
   A. Examine surfaces and areas upon which the work of this Section depends. Report to the Contractor in writing, defects of work prepared by other trades and other unsatisfactory site conditions which would cause defective installation of products, or cause latent defects in workmanship and function.
   B. Verify site dimensions.
   C. Commencement of work will imply acceptance of prepared work.

3.02 INSTALLATION
   A. Install equipment in accordance with approved shop drawings and manufacturer's recommendations.
   B. Co-ordinate installation with work of related trades.
   C. Install all work true, level, tightly fitted and flush with adjacent surfaces as required.
   D. Structural steel to receive davit base to have adequate bearing surface as indicated on shop drawings and/or to ensure 100% weld.
   E. Manufacturer to assist and/or supervise installation of suspended maintenance equipment installed by others.

3.03 FINAL ADJUSTING AND INSPECTION
   A. Adjust and leave equipment in proper working order.

3.04 TESTING
   A. All anchorage systems relying upon chemical adhesive fasteners to be 100% tested on site using load cell test apparatus in accordance with manufacturer's recommendations.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Kitchen appliances.
   B. Laundry appliances.

1.02  RELATED REQUIREMENTS
   A. Section 26 27 17 - Equipment Wiring: Electrical connections for appliances.

1.03  REFERENCE STANDARDS
   B. Energy Star - A voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions through a joint effort between the U.S. Environmental Protection Agency and the U.S. Department of Energy.

1.04  SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.
   C. Copies of Warranties: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05  QUALITY ASSURANCE
   A. Electric Appliances: Listed and labeled by UL and complying with NEMA standards.
   B. Gas Appliances: Bearing design certification seal of AGA.

1.06  WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five (5) year manufacturer warranty on refrigeration system of refrigerators.
   C. Provide ten (10) year manufacturer warranty on magnetron tube of microwave ovens.
   D. Provide ten (10) year manufacturer warranty on tub and door liner of dishwashers.

PART 2  PRODUCTS

2.01  KITCHEN APPLIANCES
      1. Capacity: Total minimum storage of 18 cubic ft; minimum 15 percent freezer capacity.
      2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by DOE.
      3. Features: Include glass shelves, automatic icemaker, light in freezer compartment, and in-door water and ice dispenser.
      4. Finish: Porcelain enameled steel, color as indicated.
   B. Range: Electric, free-standing, with glass-ceramic cooktop.
      1. Size: 30 inches.
      2. Oven: Self-cleaning.
      5. Features: Include automatic meat thermometer, storage drawer, oven door window, broiler pan and grid, and oven light.
      6. Finish: Porcelain enameled steel, color as indicated.
   C. Cooking Exhaust: Range hood.
      1. Size: 30 inches.
      2. Fan: Single-speed, 500 cfm
      3. Exhaust: Rectangular, vented to exterior.
RESIDENTIAL APPLIANCES

4. Features: Include cooktop light and removable grease filter.
5. Finish: Painted steel, color as indicated.

D. Dishwasher: Undercounter.
   2. Wash Levels: 3.
   3. Cycles: 4, including normal.
   4. Features: Include rinse aid dispenser, optional no-heat dry, optional water temperature boost, adjustable upper rack, and adjustable lower rack.
   5. Finish: Porcelain enameled steel, color as indicated.

2.02 LAUNDRY APPLIANCES

A. Clothes Washer: Front-loading.
   1. Size: Large capacity.
   2. Controls: Solid state electronic.
   6. Finish: Painted steel, color as indicated.

B. Clothes Dryer: Electric, stationary.
   1. Size: Large capacity.
   2. Controls: Solid state electronic, with electronic moisture-sensing dry control.
   3. Temperature Selections: One.
   5. Features: Include interior light, reversible door, stationary rack, sound insulation, and end of cycle signal.
   6. Finish: Painted steel, color as indicated.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.02 SCHEDULE

A. REF-1
   1. Location: Women's Center
   2. Manufacturer: TBD
   3. Product: Under-Counter Refrigerator

B. REF-2
   1. Location: Cultural Forum
   2. Manufacturer: TBD
   3. Product: TBD

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Front projection screen assemblies.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's catalog cuts and descriptive information on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Wiring diagrams for motor operators and actuators, and controls and switches.
C. Shop Drawings: For custom installations, indicate dimensions, verified field measurements, mounting details, and interface with adjacent construction.
D. Samples: For screen fabrics, submit two 4 by in size.
E. Operation and Maintenance Data: Provide manufacturer's operation and maintenance instructions.
F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE
A. Manufacturer Qualifications: Experienced in manufacturing products specified in this section.
B. Installer Qualifications: Experienced in installation of the work of this section.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Deliver projection screens to project site in manufacturer's original unopened packaging. Inspect for damage and size before accepting delivery.
B. Store in a protected, clean, dry area with temperature maintained above 50 degrees F. Stack according to manufacturer's recommendations.
C. Acclimate screens to building temperatures for 24 hours prior to installation, or in accordance with manufacturer's recommendations.

1.05 FIELD CONDITIONS
A. Maintain interior of building between 60 degrees F and 75 degrees F during and after installation of projection screens.

1.06 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer warranty for projection screen assembly.

PART 2 PRODUCTS

2.01 MANUFACTURERS
E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FRONT PROJECTION SCREENS
A. Front Projection Screens: Factory assembled unless otherwise indicated.
B. Provide mounting hardware, brackets, supports, fasteners, and other mounting accessories required for a complete installation, in accordance with manufacturer's recommendations for specified substrates and mountings.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that substrate is finished and ready to accept screen installation.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
   C. Do not install projection screens until climate control systems are in place and interior painting and other finishes are completed.

3.02 PREPARATION
   A. Coordinate screen installation with installation of projection systems.
   B. Coordinate installation with adjacent construction and fixtures, including ceilings, walls, lighting, fire suppression, and registers and grilles.

3.03 INSTALLATION
   A. Install in accordance with manufacturer's instructions, using manufacturer's recommended hardware for relevant substrates.
   B. Do not field cut screens.
   C. Install screens in mountings as specified and as indicated on drawings.
   D. Install plumb and level.
   E. Adjust projection screens and related hardware in accordance with manufacturer's instructions for proper placement and operation.

3.04 PROTECTION
   A. Protect installed products until completion of project.
   B. Touch up, repair, or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Formed steel track.
   B. Nylon carriers, cords, and accessories.

1.02 ADMINISTRATIVE REQUIREMENTS
   A. Coordinate location and installation of concealed blocking for support of tracks.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide track profiles, acceptable load data, finishes available, and electrical characteristics and connection requirements.
   C. Shop Drawings: Indicate end track location, width of window opening, location of blocking for anchors, appurtenances and interferences, adjacent construction, operating hardware, and support bracket details.
   D. Manufacturer's Installation Instructions: Indicate procedures, perimeter conditions requiring attention.
   E. Maintenance Data: Include data for motor, shaft and gearing, lubrication frequency, control adjustments, spare part sources.
   F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.
      2. Extra Carriers: Quantity equal to 5 percent of those installed.
      3. Extra Control Cords/Wands: Two of each type installed.

1.04 QUALITY ASSURANCE
   A. Manufacturer: Company specializing in manufacturing the products specified in this section, with minimum three years of documented experience.

1.05 MOCK-UP
   A. Provide one full drapery track run in designed location as an integral part of a window and ceiling intersection assembly.
   B. Locate where directed.
   C. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Drapery Track:
      3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS
   A. Tracks: Formed steel, bi-parting operating traverse rods, regular duty channel track.
   B. Track Brackets: Formed steel wall type, for recessed installation, with screws and inserts for attachment.
   C. Carriers: Nylon roller 3 per foot, ________ type.
   D. Cord: Braided nylon; continuous loop, free end weighted.

2.03 FINISHES
   A. Exposed Surfaces: Baked enamel, white.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that concealed anchors are in correct position.
   B. Verify that electrical service is correctly located and of proper characteristics.

3.02 INSTALLATION
   A. Install drapery tracks in accordance with manufacturer's instructions.
   B. Extend track 12 inches both sides with window trim for single track; 18 inches for double track where exposed.
   C. Mount track support brackets on solid backing. Where mounting location does not align with solid backing, provide expanding anchors for each screw hole location.
   D. Anchor tension pulley to wall.
   E. Set cord pulls so that cord pull is 12 inches below window sill in full open position.

3.03 ADJUSTING
   A. Adjust drapery hardware for smooth operation.

END OF SECTION
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Manually operated roller shades.
   1. Sunscreen roller shades.
   2. Room-darkening shades.
   3. Double-roller sunscreen and room-darkening shades

B. Electrically operated roller shades.
   1. Sunscreen roller shades.
   2. Double-roller sunscreen and room-darkening shades.

C. Local group and master control system for shade operation.

D. Local group and master control system for shade operation with addressable motors.

1.02 REFERENCE STANDARDS


B. NFPA 70 - National Electrical Code.


D. WCMA A100.1 - Safety of Corded Window Covering Products; Window Covering Manufacturers Association; 2007. (ANSI/WCMA A101.1)

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: For each type of product indicated, include:
   1. Styles, material descriptions, construction details, dimensions of individual components, profiles, features, finishes and operating instructions.
   2. Preparation instructions and recommendations, mounting details and installation methods.
   3. Storage and handling requirements and recommendations.
   5. Typical wiring diagrams including integration of motor controllers with building management system, audiovisual and lighting control systems as applicable.

C. Shop Drawings: Manufacturer's data sheets on each product to be used, including: location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.

D. 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:
   1. Ceiling suspension system members and attachment to building structure.
   2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
   3. Shade mounting assembly and attachment.
   4. Size and location of access to shade operator and adjustable components.
   5. Minimum Drawing Scale: 1/4 inch = 1 foot.

E. Selection Samples: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.

F. Samples for Verification:
   1. For the following products:
      a. Shade Material: Not less than 12-inch- square section of fabric, from dye lot used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of material.
b. Valance: Full-size unit, not less than 12 inches long.

G. Window Treatment Schedule: For roller shades using same designations indicated on Drawings and include opening sizes and key to typical mounting details.

H. Maintenance Data: Include methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls, in maintenance manuals

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of five years experience in manufacturing products comparable to those specified in this section.

B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of five years experience installing products comparable to those specified in this section.

C. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

D. Product Standard: Provide roller shades complying with WCMA A 100.1.

E. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Contracting Officer of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.07 WARRANTY

A. Roller Shade Hardware, Chain and Shadecloth (except EcoVeilä): Manufacturer's standard non-depreciating twenty-five year limited warranty.
   1. EcoVeil standard non-depreciating 10-year limited warranty.
   2. ** NOTE TO SPECIFIER ** Delete paragraph below if no electrically-operated roller shades.

B. Roller Shade Motors and Motor Control Systems: Manufacturer's standard non-depreciating five-year warranty.

C. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas.

1.08 EXTRA MATERIALS

1.09 EXTRA MATERIALS MAY NOT BE ALLOWED FOR PUBLICLY FUNDED PROJECTS.

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.

B. Revise subparagraph below to suit Project. Replace percentage with a specific number of units and replace "units" with an expanded description of each unit.
1. Rollers Shades: Before installation begins, for each size, color, texture, and pattern indicated, full-size units equal to 5 percent of amount installed, but not fewer than <Insert number> units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manually Operated Roller Shades:
   1. Basis of Design:
   2. Acceptable manufacturers pending conformance to basis of Design requirements:
      b. Solarfective Products Limited; www.solarfective.com
      c. Nysan Shading Systems Ltd.; www.nysan.com
      d. Substitutions: See Section 01 60 00 - Product Requirements.

B. Electrically operated roller shades:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Eco Veil or a comparable product by one of the following:
   2. Acceptable manufacturers pending conformance to basis of Design requirements:
      c. Phifer Incorporated; SheerWeave Infinity; www.phifer.com
      e. Nysan Shading Systems Ltd.;
      f. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 COMPONENTS

A. Shade Band Material: Fiberglass and acrylic blend.
   1. Fabric Width: As indicated on Drawings.
   2. Pattern: Mesh
   3. Style: EcoVeil by MechoShade or equivalent.
   4. Colors: white
   6. Material Openness Factor: 30 percent.
   7. Material UV Blockage: 85 percent.
   8. Retain or delete three subparagraphs below to suit product and Project. Not all manufacturers offer all these options; style options for hem, trim, and fringe are more typical for residential applications.

B. Rollers:
   1. Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging.
   2. Designed to be easily removable from support brackets.
   3. Removable spline fitting integral channel in tube manufacturer's standard method for attaching shade material.
   4. Provide capacity for one roller shade band(s) per roller, unless otherwise indicated on Drawings.
   5. Installations with a single row of aligned rollers are either regular or reverse roll. Installations with a double row of queued or overlapping rollers can be same roll or opposite. Coordinate direction of roll with fascia and pocket design.
   6. Direction of Roll: Regular, from back of roller.

C. Mounting Brackets (exposed to view or in ceiling pocket-delete if D below is used):
1. Fascia end caps, fabricated from steel finished to match fascia or headbox.

D. Mounting (delete if C above is used):
   1. Retain first paragraph below if fascia alone or combined fascia and top/back cover headbox suit Project. Typically fascia panels are available up to 16 feet (4.9 m) long. Delete if retaining “Pocket-Style Headbox” or “Pocket with Ceiling Slot Opening” Paragraph.

E. Standard Headbox Installation:
   1. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated on Drawings; removable design for access.
   2. Top/Back Cover: L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.
   3. OR
   4. Pocket-Style Headbox: U-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.

F. Bottom Bar: Steel or extruded aluminum, with plastic or metal capped ends. Provide exposed-to-view, external-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

G. Retain, revise, or delete paragraph and subparagraphs below as required for Project and product. If retaining below but not all shades are audiovisual light-blocking shades, differentiate between shades on Drawings, in a schedule, or by designation in article title and copying and editing content for each type of shade.

H. Mounting: As indicated on Drawings, mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

I. Shade Operation: Manual; with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator.
   1. Position of Clutch Operator: As indicated on Drawings.
   2. Position of Clutch Operator: Left side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings.
   3. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
   4. Lift-Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
   5. Loop Length: Length required to make operation convenient from floor level.

2.03 SHADE MOTOR DRIVE SYSTEM

A. Shade Motors:
   1. Tubular, asynchronous (non-synchronous) motors, with built-in reversible capacitor operating at 110v AC (60hz), single phase, temperature Class A, thermally protected, totally enclosed, maintenance free with line voltage power supply equipped with locking disconnect plug assembly furnished with each motor.
   2. Conceal motors inside shade roller tube.
   3. Maximum current draw for each shade motor of 2.3 amps.
   4. Use motors rated at the same nominal speed for all shades in the same room.

B. Total hanging weight of shade band shall not exceed 80 percent of the rated lifting capacity of the shade motor and tube assembly.
2.04 MOTOR CONTROL SYSTEMS

A. IQ/MLC: Specifications and design of shade motors and motor control system are based on the IQ/MLC motor logic control system manufactured by MechoShade Systems, Inc. Other systems may be acceptable provided that all of the following performance capabilities are provided. Motor logic control systems not in complete compliance with these performance criteria shall not be accepted as equal systems.

1. Motor Control System:
   a. Provide power to each shade motor via individual 3 conductor line voltage circuits connecting each motor to the relay based motor logic controllers (IQ/MLC).
   b. Control system components shall provide appropriate (spike and brown out) over-current protection (+/- 10 percent of line voltage) for each of the four individual motor circuits and shall be rated by UL or ETL as a recognized component of this system and tested as an integrated system.
   c. Motor control system shall allow each group of four shade motors in any combination to be controlled by each of four local switch ports, with up to fourteen possible "sub-group" combinations via local 3 button wall switches and all at once via a master 3 button switch. System shall allow for overlapping switch combinations from two or more local switches.
   d. Multiple "sub-groups" from different IQ/MLC control components shall be capable of being combined to form "groups" operated by a single 3 button wall switch, from either the master port or in series from a local switch port.
   e. Each shade motor shall be accessible (for control purposes) from up to four local switches and one master switch.
   f. Control system shall allow for automatic alignment of shade hem bars in stopped position at 25 percent, 50 percent, and 75 percent of opening heights, and up to three user-defined intermediate stopping positions in addition to all up / all down, regardless of shade height, for a total of five positions. Control system shall allow shades to be stopped at any point in the opening height noting that shades may not be in alignment at these non-defined positions).
   g. Control system shall have two standard operating modes: Normal mode allowing the shades to be stopped anywhere in the window's opening height and uniform mode, allowing the shades to only be stopped at the predefined intermediate stop positions. Both modes shall allow for all up / all down positioning.
   h. Control system components shall allow for interface with both audiovisual system components and building fire and life safety system via a dry contact terminal block.
   i. Control system components shall allow for interface with external analog input control devices such as solar activated controllers, 24 hour timers, and similar items; via a dry contact terminal block.
   j. Reconfiguration of switch groups shall not require rewiring of the hardwired line voltage motor power supply wiring, or the low voltage control wiring. Reconfiguration of switch groups shall be accomplished within the motor control device (IQ/MLC).

2. Wall Switches:
   a. Three-button architectural flush mounted switches with metal cover plate and no exposed fasteners.
   b. Connect local wall switches to control system components via low voltage (12V DC) 4-conductor modular cable equipped with RJ-11 type connectors supplied, installed and certified under Division 16 - Electrical.
   c. Connect master wall switches to control system components via low voltage (12V DC) 6-conductor modular cable equipped with RJ-12 type connectors supplied, installed and certified under Division 16 - Electrical.

B. **NOTE TO SPECIFIER** The I.CON system is a fully digital, fully addressable system ideal for large scale projects. The control wiring can be implemented in a free topology providing maximum flexibility, and can be managed by a building management system or other central control software such as MechoShade's AAC/SOLARTRAC System.
C. I.CON Control System (Software, two way communication): Specifications and design are based on the I.CON motor control system as manufactured by MechoShade Systems, Inc. Other systems may be acceptable provided that all of the following performance capabilities are provided. Motor control systems not in complete compliance with these performance criteria shall not be accepted as equal systems.

1. Upper and lower stopping points (operating limits) of shadebands shall be programmed into motors via a hand held removable program module / configurator.
2. Intermediate stopping positions for shades shall be 4 predefined intermediate positions, for a total of 6 defined and aligned positions. All shades on the same switch circuit with the same opening height shall align at each intermediate stopping position.
3. Motors shall be addressable through a 2 motor bus interface module via a hand-held removable program module and shall be capable of responding to a minimum of seven different user defined stored addresses including multiple overlapping sub groups and three reserved control input addresses for use by building management systems, life safety systems and other emergency inputs.
4. The BI and I.CON controller system shall have the capability of two-way communication with the motors. Each I.CON controller, (bus Interface or BI) shall allow for a unique address message to be received from the hand held configurator and/or a PC controller or switch.

   a. Bus line shall consist of 2 twisted pair of 16 ga low voltage wire.
   b. Shade motor control components (bus interfaces, wall switches, bus supplies, auxiliary control input devices, and similar items) shall be connected in series via the low voltage (12VDC) two way digital communication bus line.
   c. Bus line shall be capable of being installed in a free topology to provide maximum flexibility for installation and future maintenance.
   d. Low voltage (12VDC) digital bus line shall be powered by a bus supply transformer, requiring 115VAC (220 - 230 VAC) input drawing a maximum current of 1 amp. A minimum of one bus supply shall be required for every 400 linear feet of bus line. Final bus supply spacing shall be reviewed with the system manufacturer after the number of nodes per 400 ft (120 meters) run of bus line has been determined.

5. Wall Switches:
   a. Shades shall be operated by 4 button low voltage standard switches or programmable intelligent switches [IS]. Standard switch shall be wired to a bus interface and the bus interface will be programmed to transmit an address for the local switch.
   b. Intelligent switches may be installed anywhere on the busline. Each IS shall be capable of storing one control level address to be broadcast along the busline.
   c. An address that is transmitted by either a switch or central controller shall be responded to by those motors with the same address in their control table.
   d. IS shall provide for interface with other low voltage input devices via a set of dry contact terminals located on the switch.
   e. Standard switch or IS may control an individual, sub-group or group of motors in accordance with the address in each motor/BI unit.

2.05 ACCESSORIES

A. Roller Shade Pocket for recessed mounting in acoustical tile, or drywall ceilings as indicated on the Drawings (for Shade Type ??).
   1. Provide either extruded aluminum and or formed steel shade pocket, sized to accommodate roller shades, with exposed extruded aluminum closure mount, tile support and removable closure panel to provide access to shades.
      a. Provide “Vented Pocket” such that there will be a minimum of four 1 inch (25.4 mm) diameter holes per foot allowing the solar gain to flow above the ceiling line

B. Fascia (for Shade Type ??):
   1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
2. Fascia shall be able to be installed across two or more shade bands in one piece.
3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
4. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
5. Notching of Fascia for manual chain shall not be acceptable.
6. ** NOTE TO SPECIFIER ** Delete below if not required. Coordinate Shade Type with Shade Type on the Drawings and as listed in Part 2 of this Section.

C. Room Darkening Side and / or Sill Channels (for Shade Type ??):
1. Extruded aluminum with polybond edge seals and SnapLoc-mounting brackets and with concealed fastening. Exposed fastening is not acceptable. Channels shall accept one-piece exposed blackout hembar with vinyl seal to assure side light control and sill light control.
   a. MechoShade side channels, 1-15/16 inches (49.2 mm) wide by 1-3/16 inches (30.1 mm) deep, two-band center channels, 2-5/8 inches (66.6 mm) wide by 1-3/16 inches (30.1 mm) deep. The 2-5/8-inch (66.6 mm) double-center channels may be installed at center-support positions of multi-band-shade ElectroShades. MechoShade side channels 2-5/8 inch (66.6 mm) may be used as center supports for ElectroShades; shadebands up to 8 high. For shadebands over 8 feet (2438 mm), provide ElectroShade side channels.
   b. ElectroShade side channels, 2-1/2 inches (63.5 mm) wide by 1-3/16 inches (30.1 mm) deep; two-band center channels 5 inches (127 mm) wide by 1-3/16 inches (30.1 mm) deep. The 2-5/8-inch (66.6 mm) double-center channels may be installed at center-support positions of multi-band-shade ElectroShades. MechoShade side channels 2-5/8 inches (66.6 mm) may be used as center supports for ElectroShades. Also provide for use with manually operated room darkening MechoShades over 8 feet (2438 mm) in height.
   c. ** NOTE TO SPECIFIER ** Delete one of the two following paragraphs.
   d. Color: Selected from manufacturer's standard colors.
   e. Color: Custom color as selected by Architect.

2.06 FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
   1. Lifting Mechanism: With permanently lubricated moving parts.

C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
   1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.
   2. Delete subparagraph above or below if not applicable. Revise subparagraph above if heat-strengthened glass is not specified and if compliance with recommendations in GANA's "Glazing Manual" for clearances between top, bottom, and sides of opening and shade suits Project. Coordinate requirements for perimeter clearances with distance between shades and glass, glass type, and placement of heating/cooling air supplies to avoid heat buildup and possible damage to glass.
   3. Shade Units Installed Outside Jambs: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting fascia, roller, and operating hardware and for hardware position and shade mounting method indicated.
E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. Finish: Color-Coat metal components exposed to view. Apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

G. Finish: Clear anodized aluminum metal components exposed to view. Apply manufacturer's standard anodic finish complying with manufacturer's written instructions for surface preparation including pretreatment.

H. Colors of Metal and Plastic Components Exposed to View: Matching or coordinating with shade band color, unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that openings are ready to receive the work.
B. Ensure structural blocking and supports are correctly placed.
C. Examine conditions for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance.
D. Do not begin installation until substrates have been properly prepared.
E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 COORDINATION

A. Coordinate requirements for distance between roller shades and glass with clearances between shade perimeter and surrounding construction, glass type, and placement of heating/cooling air supplies to avoid heat buildup and possible damage to glass. Generally retain option for 2 inches (50 mm) in paragraph below. See Evaluations and GANA's "Glazing Manual."

3.04 INSTALLATION

A. Install shades in accordance with manufacturer's instructions.
B. Install level, plumb, and aligned with adjacent units, and located so shade band is not closer than 2 inches to interior face of glass and allow clearances for window operation hardware.

3.05 ELECTRICAL CONNECTIONS

A. See manufacturer's instructions in "Evaluations" for cautions about improper wiring.
B. Connections: Connect motorized operators to building electrical system.

3.06 ADJUSTING

A. Adjust and balance shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.07 CLEANING AND PROTECTION

A. Clean shade surfaces after installation, according to manufacturer's written instructions.
B. Protect installed products until completion of project.
C. Touch-up, repair or replace damaged products before Substantial Completion.
3.08 ELECTRICAL OPERATION DEMONSTRATION
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades. Refer to Division 1 Section Demonstration and Training.

3.09 SCHEDULE
   A. RS-1
      1. Not Used
   B. RS-2
      1. Location: Ground Floor Medium Conference Room at Student Street, Very Large Dividable Conference Room
      2. Basis of Design Manufacturer: Mechoshade
      3. Product: Electroshade
      4. Shadecloth: EcoVeil 1550 series, 100% Thermoplastic Olefin (3% open)
      5. Color: 1569 Silver Birch
   C. RS-3
      1. Location: Multifunctional Auditorium
      2. Basis of Design Manufacturer: Mechoshade
      3. Product: Electroshade
      4. Shadecloth: Midnite Blackout 0200 Series
      5. Color: TBD

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Extruded aluminum entrance floor grilles.
B. Stainless steel entrance floor gratings.
C. Carpet mat.
D. Recessed mat frames.

1.02 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating properties of walk-off surface, component dimensions and recessed frame characteristics.
C. Shop Drawings: Indicate dimensions and details for recessed frame.
   1. For recessed frames located within a dimensionally restricted area, show dimensions of space within which the frame will be installed.
D. LEED Submittals: Report recycled content and source of product.
E. Maintenance Data: Include cleaning instructions, stain removal procedures and ________.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Entrance Floor Gratings:
   2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Floor Mats:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ENTRANCE FLOOR GRILLES AND GRATINGS
A. Entrance Floor Grilles: Recessed extruded aluminum grille assembly with nominal 1 inch wide tread strips running perpendicular to traffic flow, slots between treads, and perimeter frame forming sides of recess; grille hinged for access to recess.
   1. Recess Depth:  3/4 inches.
   2. Length in Direction of Traffic Flow:  72 inches.
   4. Frame: Anodized aluminum for embedding in concrete; minimal exposed trim; stud or hook concrete anchors.
B. Entrance Floor Gratings: Recessed stainless steel bar grating with longitudinal bars running perpendicular to traffic flow and perimeter frame forming sides of recess; grating hinged for access to recess.
   1. Grating: Longitudinal bars 0.09 inch, nominal, in width, spaced at less than twice the bar width apart; cross bars set below for pronounced linear appearance.
   2. Grating Depth:  3/8 inches, nominal.
   3. Recess Depth Below Bottom of Grating:  1 inches.
   6. Frame: Anodized aluminum for embedding in concrete; minimal exposed trim; stud or hook concrete anchors.
C. Mounting: Top of non-resilient members level with adjacent floor.
D. Structural Capacity: Capable of supporting a rolling load of 500 pounds without permanent deformation or noticeable deflection.
E. Vibration Resistant Fabrication: All members welded, riveted, or bolted; no snap or friction connections.

2.03 MATS
   A. Carpet Mat: Cut nylon pile permanently bonded to vinyl backing; _____ inch wide x _____ inch long with one inch black matching vinyl border on all edges.
      1. Colors: To be selected by Architect from manufacturer's standard range.
   B. Recessed Frame: _____ inch thick zinc exposed top strip, zinc coated steel concealed bottom strip, _____ inch deep, with anchoring features.

2.04 FABRICATION
   A. Construct recessed mat frames square, tight joints at corners, rigid. Coat surfaces with protective coating where in contact with cementitious materials.
   B. Fabricate mats in single unit sizes; fabricate multiple mats where indicated.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that floor opening for mats are ready to receive work.

3.02 PREPARATION
   A. Mats: Verify size of floor recess before fabricating mats.
   B. Vacuum clean floor recess.

3.03 INSTALLATION
   A. Install frames to achieve flush plane with finished floor surface.
   B. Install walk-off surface in floor recess flush with finish floor after cleaning of finish flooring.

3.04 SCHEDULES
   A. WOG-1
      1. Location: Exterior Walk-Off Grilles at North Wing
      2. Manufacturer: Kadee Industries/Mats Inc.
      3. Product: Metal Walk-Off Grille
      4. Recessed in Slab

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Telescoping bleachers.
   B. Electric motor operators, controls, and internal wiring.

1.02 RELATED REQUIREMENTS
   A. Section 26 27 26 - Wiring Devices: Key-operated wall switch(es).
   B. Section 26 27 17 - Equipment Wiring: Connection of electric motors and controls.

1.03 REFERENCE STANDARDS
   B. PS 1 - Structural Plywood; 2009.
   D. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society; 2008.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage handling and requirements.
      3. Installation methods.
   C. Shop Drawings: Complete layout with dimensions, seat heights, row spacing and rise, aisle widths and locations, points of connection to substrate, assembly dimensions, and material types and finishes.
      1. Provide drawings customized to this project.
      2. Include Professional Engineer certification.
   D. Operation and Maintenance Data: Manufacturer's operation and maintenance instructions, including annual inspection and maintenance and bi-annual inspection by a Professional Engineer or manufacturer factory service personnel.
   E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
   B. Installer Qualifications: Manufacturer's installation crew.
   C. Welder Qualifications: Certified by AWS for the process employed.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Store, in original packaging, under cover and elevated above grade.

1.07 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a five year period after Date of Substantial Completion. Replace parts that fail under normal use at no extra charge to Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Telescoping Bleachers:
2.02 TELESCOPING BLEACHERS

A. Telescoping Bleachers: Factory assembled tiered benches that retract horizontally into depth approximately the same as a single row depth, with fixed seats mounted on leading edge of platforms.
   1. Design to comply with applicable requirements of NFPA 102 and requirements of code authorities having jurisdiction; where conflicts between requirements occur, comply with whichever is more stringent.
   2. Design with solid fascia (riser) or seat fronts that conceal interior mechanisms when fully retracted, fitting tightly enough to prevent climbing up face; at front row provide key locked, hinged fascia (skirt) to cover gap between seat riser/fascia and floor.

B. Design Loads: Design to withstand the following loading conditions:
   1. Live Load on Structural Supports: 100 psf, minimum, of gross horizontal projection.
   2. Live Load on Seats and Walking Surfaces: 120 pounds per linear foot.
   3. Lateral Sway Stress on Structural Supports: 24 pounds per linear foot of seat plank.
   4. Perpendicular Sway Stress on Structural Supports: 10 pounds per linear foot of seat plank.

C. Dimensions:
   1. Rows: __
   2. Rise Per Row: 10 inches.
   3. Row Depth: 22 inches.
   4. Seat Height Above Tread: 6 inches.

D. Structural Supports: Steel or aluminum; manufacturer's standard wheeled carriages supporting each tier separately, with moving parts permanently lubricated and metal parts cushioned to prevent metal-to-metal contact during operation.
   1. Design so that each row carriage so that it will individually support the design loads and is self supporting when fully assembled without dependence on platform panels or boards, seats, or fascia.
   2. Welding: In accordance with AWS D1.1 and AWS D1.3.
   3. Bolting: Use lock-washers or locknuts.
   4. Wheels: Minimum 5 inch diameter by 1-1/8 inch wide, with non-marring rubber tires; ball, roller, or oil-impregnated metal bearings; minimum of 2 wheels at each floor support.
   5. Finish: Manufacturer's standard enamel or powder coating.
   6. Row Locking: Automatically mechanically lock each carriage to adjacent carriages when fully extended.
   7. Unlocking: Automatically unlock all rows before engaging retraction mechanism.

E. Motor Operation: Manufacturer's standard drive mechanism, using motor adequately sized for the purpose.
   1. All electrical components and wiring UL listed.
   2. Controls: Start, Stop, Forward, and Reverse in a single control unit.
   3. Control Station: Removable plug-in low-voltage pendant station, with first-row plug-in location for each motor.
   4. Limit Switches: Automatically stop operation when unit has reached fully open or fully closed position.
   5. Provide all wiring internal to bleacher units, to junction box located where indicated; ensure that wiring is not energized except during operation.
   6. Electrical Characteristics: 120V, single phase, 60 Hz.
   7. Provide access to motor from front side of bleachers; a hinged front skirt or hinged section at least 30 inches wide is acceptable.

2.03 SEAT AND PLATFORM COMPONENTS

A. Platform, Tread, and Step Structure: Plywood continuously supported on front and rear with side joints tongue-and-grooved.
TELESCOPING BLEACHERS

1. Plywood: PS 1, 5-ply southern pine or polyethylene-overlaid Douglas fir or southern pine, Grade A-C.
3. Front (Nose), Rear, and Intermediate Supports: Steel channel or tube, hot-dipped galvanized.
4. Provide end caps of same material and finish on each exposed end.

2.04 HANDRAILS AND RAILINGS

A. Provide the following railings:
   1. Height: 42 inches above adjacent platform or tread.
B. Design handrails and railings to withstand the following loads:
C. Railing Construction: Round steel or aluminum pipe or tube, with formed elbows at corners and caps at ends of straight runs.
   1. Aluminum: 1.66 inches minimum outside diameter; natural anodized finish.
   2. Steel: 1-1/2 inch minimum outside diameter, with 11 gage minimum wall thickness; textured powder coat epoxy finish.

2.05 ACCESSORIES

A. Motion Monitor: Strobe light and warning horn rated at 150 dB, both of which operate continuously during movement of any section of bleachers; mount strobe light where it is clearly visible to entire bleacher installation.
B. Fasteners: Provide hardware and fasteners in accordance with manufacturer’s recommendations.
C. Anchorage: As indicated on drawings; provide hardware in accordance with manufacturer’s recommendations.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are consistent with those on the shop drawings.
B. Verify that electrical rough-ins have been installed and are accessible.
C. Do not begin installation until substrates have been properly prepared and area has been cleared of obstructions.
D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Do not field cut or alter seats, fascia, or structural members without approval.
C. Provide manufacturer's field representative to inspect completed installation.

3.04 ADJUSTING

A. Lubricate, test, and adjust each moving assembly to ensure proper operation in compliance with manufacturer's recommendations.

3.05 CLEANING

A. Clean exposed and semi-exposed assembly surfaces.
B. Touch up finishes on damaged or soiled areas.
3.06 CLOSEOUT ACTIVITIES

3.07 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Exterior Benches.
B. Bicycle Racks.
C. Bike/Skate Derrents.
D. Treee Grates.
E. Trench Drain Grates.
F. Removable Bollard.

1.2 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete:

1.3 SUBMITTALS
A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
B. Shop Drawings: Indicate size, shape, and dimensions, including clearances from adjacent walls, doors, and obstructions.
C. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns. Submit one Bike/Skate Deterrent for review and approval.

1.4 COORDINATION
A. Coordinate with other trades affecting and affected by work of this Section.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Storage and Protection:
   1. Store products in manufacturer's unopened packaging with legible manufacturer's identification until ready for installation.
   2. Use all means necessary to protect materials of this Section before, during and after installation and to protect installed work and materials of other trades.
   3. In event of damage, immediately bake all repairs and replacements necessary to approval of Owner's Authorized Representative.
   4. Store and handle materials in accordance with manufacturer's recommendations.

PART 2 PRODUCTS

2.1 BENCH - UO STANDARD
A. Owner furnished contractor installed.
   1. 5 foot long, Model #2604 Parkside Bench by Gardenside, LTD, or approved.

2.2 BENCH - BACKLESS
A. Owner furnished contractor installed.
   1. 5 foot long, Model #2314 Westwood Bench by Gardenside, LTD, or approved.

2.3 BICYCLE RACK
A. Material:
   2. Base Plate / Rail: 3" x 3/8" flat bar with 10 holes for mounting 9/16" in diameter
B. Size: 18" wide x 36" tall. 78 inches long for 4 hoop racks. 54" long for 3 hoop racks.
C. Type 1 - Owner Furnished Owner Installed.
   1. Powder coat UO Green.
**SITE FURNISHINGS**

D. Type 2 - Contractor Furnished Contractor Installed.
   1. Powder coat Black

2.4 BIKE/SKATE DETERRENT
   A. Size: Refer to Drawings.
   B. Materials/Finish: Cast bronze with brown patina.
   C. Approved Product: EMU Straddle by SkateStoppers, or approved; www.skatestoppers.com; Contact: Chris Loarie @ 619-447-6374.

2.5 REMOVABLE BOLLARD
   A. Owner Furnished Contractor Installed.
      1. Visco #VI-BO-14/30, aluminum construction, powder-coated UO Green.

2.6 TREE GRATE
   A. Material: Ductile Iron
   B. Finish: Powder Coat Brahman Beige
   C. Size: 5 foot x 5 foot (nominal)
   D. Approved product - Base Bid: Viper Tree Grate by Urban Accessories, or approved.
   E. Approved product - Deductive Alternate Bid: Flat Rainbow by Urban Accessories, or approved.

2.7 TRENCH DRAIN GRATE
   A. Material: Ductile Iron
   B. Finish: Powder Coat Brahman Beige
   C. Size: 4 inch x 18 inch (nominal)
   D. Trench drain grate to be heavy vehicle rated.
   E. Approved product - Viper Trench Grate by Urban Accessories, or approved.

**PART 3 EXECUTION**

3.1 EXAMINATION
   A. Inspection: Prior to installation of the work of this Section, carefully inspect the installed work of others and verify that all such work is complete to the point where this installation may properly commence.
   B. Discrepancies: Do not install work of this Section until all unsatisfactory conditions have been corrected. Commencing work denotes acceptance of existing conditions.

3.2 PREPARATION
   A. Ensure surfaces to receive furnishings are clean, flat, and level.

3.3 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install all products true and level.
   C. Secure as specified or as recommended by manufacturer. Obtain Owner's Representative approval of method prior to installation.

3.4 CLEANING
   A. Clean installed work to like-new condition. Do not use cleaning materials or methods that could damage finish.

3.5 PROTECTION
   A. Protect installed products until completion of project.
SITE FURNISHINGS

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Bicycle racks.

1.02 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.
   C. Shop Drawings: Indicate size, shape, and dimensions, including clearances from adjacent walls, doors, and obstructions.

1.03 DELIVERY, STORAGE, AND HANDLING
   A. Store products in manufacturer's unopened packaging until ready for installation.
   B. Handle racks with sufficient care to prevent scratches and other damage to the finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 MATERIALS
   A. Bicycle Racks: Tubular steel pipe formed to allow at least one bicycle to lock simultaneously on each bend and each end, securing one wheel and part of the frame.
      1. Capacity: 3 bicycles.
      2. Mounting: In-ground anchor.
      3. Accessories: In-ground grout cover.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Examine surfaces to receive bicycle racks.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
   C. Do not begin installation until unsatisfactory substrates have been properly repaired.

3.02 PREPARATION
   A. Ensure surfaces to receive bicycle racks are clean, flat, and level.

3.03 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install bicycle racks level, plumb, square, and correctly located as indicated on the drawings.
   C. In-Ground Anchor Installation:
      1. Prepare holes in size according to manufacturer’s instructions.
      2. Place anchoring bolts through the holes in the pipe.
      3. Lower rack into holes, ensuring the bottom of lower bends are at least 1-1/2 inch from the ground.
      4. Pour concrete and level rack.
      5. Support until dry.

3.04 CLEANING
   A. Clean installed work to like-new condition. Do not use cleaning materials or methods that could damage finish.

3.05 PROTECTION
   A. Protect installed products until completion of project.
BICYCLE RACKS

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Complete elevator systems.
   B. Elevator maintenance.

1.02 REFERENCE STANDARDS
      1. Including local jurisdiction supplements.
   D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   E. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2013.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene a meeting one week prior to starting work.
      1. Review schedule of installation, installation procedures and conditions, and coordination with related work.
      2. Review use of elevator for construction purposes, hours of use, scheduling of its use, cleanliness of cab, employment of operator, maintenance of system.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate the following information:
      1. Locations of machine room equipment: driving machines, controllers, governors and other component.
      2. Hoistway components: Car, counterweight, sheaves, machine and sheave beams, guide rails, buffers, ropes, and other components.
      3. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
      4. Individual weight of principal components; load reaction at points of support.
      5. Loads on hoisting beams and location of trolley beams.
      6. Clearances and over-travel of car and counterweight.
      7. Locations in hoistway and machine room of traveling cables and connections for car light and telephone.
      8. Location and sizes of access doors, doors, and frames.
      9. Expected heat dissipation of elevator equipment in machine room.
     10. Applicable seismic design data; certified by a licensed Professional Structural Engineer.
     11. Interface with building security system.
     12. Electrical characteristics and connection requirements.
     13. Show arrangement of equipment in machine room so rotating elements, sheaves, and other equipment can be removed for repairs or replaced without disturbing other components. Arrange equipment for clear passage through access door.

   C. Product Data: Provide data on the following items:
      1. Signal and operating fixtures, operating panels, indicators.
      2. Cab design, dimensions, layout, and components.
      3. Cab and hoistway door and frame details.
4. Electrical characteristics and connection requirements.

D. Samples: Submit two samples, 6 by 8 inch in size illustrating cab interior finishes, cab and hoistway door and frame finishes, and handrail material and finish.

E. Maintenance Contract.

F. Maintenance Data: Include:
   1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
   2. Technical information for servicing operating equipment.
   3. Legible schematic of hydraulic piping and wiring diagrams of installed electrical equipment and changes made in the Work. List symbols corresponding to identity or markings on machine room and hoistway apparatus.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with applicable code and as supplemented in this section.

B. Designer Qualifications: Design guide rails, brackets, anchors, machine anchors, and hoisting beam under direct supervision of a Professional Engineer experienced in design of work of this type and licensed in the State in which the Project is located.

C. Perform welding of steel in accordance with AWS D1.1.

D. Fabricate and install door and frame assemblies in accordance with NFPA 80.

E. Perform electrical work in accordance with NFPA 70.

F. Installer Qualifications: Employees and supervisor on payroll of elevator equipment manufacturer.

G. Products Requiring Fire Resistance Rating: Listed and classified by UL.

H. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

I. Source Limitation: Obtain components for elevator system from a single source manufacturer, or if not from a single manufacturer product must be established as an approved component typically used by the elevator manufacturer as part of the elevator manufacturer’s system.

1.06 PRE-INSTALLATION MEETING

A. Review schedule of installation, installation procedures and conditions, and coordination with related work.

B. Review use of elevator for construction purposes, hours of use, scheduling of its use, cleanliness of cab, employment of operator, maintenance of system.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide one year manufacturer warranty for elevator operating equipment and devices.

A. Provide price for service and maintenance of elevator system and components for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS


B. Acceptable Alternate Manufacturers:
   1. Kone Inc; EcoSpace: www.kone.us.

C. All components to be manufactured by same entity, unless otherwise indicated.

2.02 ELEVATORS

A. Elevator No.1: Service, gearless electric.
   1. Location: NW corner of the Hearth Area.
2. Load Capacity: 4,000 lbs.
3. Doors: Front and rear opening.
4. Speed: 150 fpm.
5. Cab Height: Standard.
6. Pit Depth: 5 feet - 0 inches.
7. Overrun: From top of upper landing to bottom of hoist beam is 13 feet - 0 inches.
8. Traction Machine Location: Overhead.

B. Elevator No. 2: Add Alternate for shaft only, no elevator doors or components, secondary rail support steel is noted generically but not designed.
1. Location: North Wing.
2. Type: Passenger, gearless electric.
3. Load Capacity: 2,500 lbs.
5. Speed: 150 fpm.
7. Pit Depth: 5 feet - 0 inches.
8. Overrun: From top of upper landing to bottom of hoist beam is 13 feet - 0 inches.

2.03 CONTROLS

A. Elevator Controls: Provide landing buttons, hall lanterns, and lobby panel.

B. Door Controls:
1. Program door control to open doors automatically when car arrives at floor.
2. Render "Door Close" button inoperative when car is standing at dispatching terminal with doors open.
3. If doors are prevented from closing for approximately ten seconds because of an obstruction, automatically disconnect door reopening devices, close doors more slowly until obstruction is cleared. Sound buzzer.
4. Door Safety Devices: Moveable, retractable safety edges, quiet in operation; equip with photo-electric light rays.

C. Landing Buttons: Stainless steel type, one for originating UP and one for originating DOWN calls, one button only at terminating landings; marked with arrows.

D. Car Direction Indicators: Illuminating white.

E. Interconnect elevator control system with building fire alarm systems.


2.04 EMERGENCY POWER

A. Arrange elevator operation to operate under emergency power when normal power supply fails.

B. Emergency Power Supply: Self-contained battery power.

2.05 MACHINE ROOM FITTINGS

A. Wall-Mounted Frames: Glazed with clear plastic; sized as required. Provide one for master electric and hydraulic schematic and one for lubrication chart. Install charts.

B. Key Cabinet: Wall-mounted, lockable, keyed to building keying system, for control/operating panel keys.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that hoistway, pit, and machine room are ready for work of this section.
C. Verify hoistway shaft and openings are of correct size and within tolerance.
D. Verify location and size of machine foundation and position of machine foundation bolts.
E. Verify that electrical power is available and of the correct characteristics.

3.02 PREPARATION
A. Arrange for temporary electrical power for installation work and testing of elevator components.

3.03 INSTALLATION
A. Install system components. Connect equipment to building utilities.
B. Provide conduit, boxes, wiring, and accessories.
C. Mount machines on vibration and acoustic isolators, on bed plate and concrete pad. Place on structural supports and bearing plates. Securely fasten to building supports. Prevent lateral displacement.
D. Accommodate equipment in space indicated.
E. Install guide rails using threaded bolts with metal shims and lock washers under nuts. Compensate for expansion and contraction movement of guide rails.
F. Accurately machine and align guide rails. Form smooth joints with machined splice plates.
G. Coordinate installation of hoistway wall construction.
H. Install hoistway door sills, frames, and headers in hoistway walls. Grout sills in place. Set entrances in vertical alignment with car openings and aligned with plumb hoistway lines.
I. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime two coats.
J. Machine Room Components: Clean and degrease; prime one coat, finish with one coat of enamel.
K. Adjust equipment for smooth and quiet operation.

3.04 ERECTION TOLERANCES
A. Guide Rail Alignment: Plumb and parallel to each other within 1/8 inch.
B. Cab Movement on Aligned Guide Rails: Smooth movement, with no objectionable lateral or oscillating movement or vibration.

3.05 FIELD QUALITY CONTROL
A. Testing and inspection by regulatory agencies will be performed at their discretion.
   1. Schedule tests with agencies and notify Owner and Architect.
   2. Obtain permits required to perform tests.
   3. Document regulatory agency tests and inspections in accordance with the requirements of Section 01 40 00.
   4. Perform tests required by regulatory agencies.
   5. Furnish test and approval certificates issued by authorities having jurisdiction.
B. Perform testing and inspection in accordance with requirements of Section 01 40 00.
   1. Perform tests as required by ASME A17.2.
   2. Provide two weeks written notice of date and time of tests.
   3. Supply instruments and execute specific tests.
C. Perform operational tests in the presence of Owner and Architect.

3.06 ADJUSTING
A. Adjust for smooth acceleration and deceleration of car so not to cause passenger discomfort.
B. Adjust automatic floor leveling feature at each floor to achieve 1/4 inch from flush.

3.07 CLEANING AND PROTECTION
A. Remove protective coverings from finished surfaces.
B. Clean surfaces and components ready for inspection.
C. Do not permit construction traffic within cab after cleaning.
3.08 MAINTENANCE

A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide a separate price for maintenance contract for specified maintenance service.

C. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the elevator manufacturer or original installer.

D. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of Owner.

E. Provide service and maintenance of elevator system and components for one year from Date of Substantial Completion.

F. Examine system components monthly. Clean, adjust, and lubricate equipment.

G. Include systematic examination, adjustment, and lubrication of elevator equipment. Maintain hydraulic fluid levels. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original equipment. Replace wire ropes when necessary to maintain the required factor of safety.

H. Perform work without removing cars during peak traffic periods.

I. Provide emergency call back service at all hours for this maintenance period.

J. Maintain an adequate stock of parts for replacement or emergency purposes locally, near the place of the Work. Have personnel available to ensure the fulfillment of this maintenance service, without unreasonable loss of time.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Fire Protection Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record Drawings
   5. Start-up Service and Building Commissioning
   6. Instruction, Maintenance, and O & M Manuals
   7. Work associated with Delivery, Storage, and Handling of products
   8. Work associated with provision of Temporary Facilities
   9. Preparation of Posted Operating Instructions
   10. Meeting Project Safety and Indemnity requirements
   11. Proper Cleaning and Closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of Supports and Anchors
   15. Pipe Portals
   16. Access Panels and Doors
   17. Identification Markers
   18. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete fire protection systems for the building.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the equipment and risers and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Where project involves interface with existing building and site systems, effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.
1.5 **DEFINITIONS**

A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.

B. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

C. "Below Grade": Buried in the ground or embedded in concrete slab on ground.

D. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

E. "Connect": Complete hook-up of item with required service.

F. "Exposed": Not installed underground or "concealed."

G. "Furnish": To supply equipment and products as specified.

H. "Indicated," "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.

I. "Install": To erect, mount and connect complete with related accessories.

J. "Motor Controllers": Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.

K. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

L. "Provide": To supply, install and connect as specified for a complete, safe and operationally ready system.

M. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.

N. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

O. "Shall": An exhortation or command to complete the specified task.

P. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

Q. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

R. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

S. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

T. "Wiring": Raceway, fittings, wire, boxes and related items.

U. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 **RELATED WORK SPECIFIED ELSEWHERE**

A. All Division 21 Fire Suppression sections included herein.

B. Division 02: Existing Conditions. Coordinate with Civil Engineer.
   1. Coordination of excavation of trenches and the installation of piping on site.

C. Division 07: Thermal and Moisture Protection.
   1. Sealants and caulking
   2. Firestopping
D. Division 09: Finishes:
   1. Division 21 installers shall perform all painting, except where specifically stated otherwise in Division 09.

E. Division 26: Electrical is related to work of:
   1. Fire protection alarms and relays
   2. Detectors and monitoring
   3. Life safety provisions

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 21 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

E. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
      b. 2010 Oregon Mechanical Specialty Code (OMSC) based on 2009 International Mechanical Code (IMC) and International Fuel Gas Code (IFGC) with State Amendments
      c. 2011 Oregon Plumbing Code (OPC) based on 2009 Uniform Plumbing Code (UPC) with State Amendments
      d. Oregon Fire Code (Based on the International Fire Code)
      e. National Electric Code (NEC) with State Amendments
   2. Local, city, county and state codes and ordinances
   3. Local Bureau of Buildings
   4. Local Health Department
   5. Local and State Fire Prevention Districts
   6. State Administrative Codes

F. Provide in accordance with appropriate referenced standards of the following:
   1. NFPA - National Fire Protection Association
   2. CSA - Canadian Standards Association
   3. ANSI - American National Standards Institute
   4. ASME - American Society of Mechanical Engineers
   5. ASTM - American Society for Testing Materials
   6. AWS - American Welding Society
   7. AWWA - American Water Works Association
   8. FM - Factory Mutual
   9. MSS - Manufacturer's Standardization Society
   10. NEMA - National Electrical Manufacturer's Association
   11. UL - Underwriter's Laboratories
   12. ADA - Americans with Disabilities Act
   13. ETL - Electrical Testing Laboratories
   14. IAPMO - International Association of Plumbing and Mechanical Officials
1.8 QUALITY ASSURANCE

A. Manufacturer’s Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375”), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.

B. Current Models. All work shall be as follows:
1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 21, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permits, licenses, fees and inspections.

D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.

E. Coordinate equipment and materials installation with other building components.

F. Verify all dimensions by field measurements.

G. Arrange for chases, slots, and openings in other building components to allow for installations.

H. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

I. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of the work. Give particular attention to equipment requiring positioning prior to closing-in the building.

J. Coordinate the cutting and patching of building components to accommodate the installation of equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.

K. Install fire protection services and overhead equipment to provide the maximum headroom possible.

L. Install equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

M. Coordinate the installation of materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, and other installations.

N. Coordinate connection of systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

O. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

P. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory.
BASIC MATERIALS AND METHODS – FIRE PROTECTION

testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

Q. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

R. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.10 MINOR DEVIATIONS

A. The Contractor shall review the structural and architectural conditions and drawings affecting his work. It is the specific intention of this section that the contractor's scope of work shall include

1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications

2. Minor deviations from the mechanical plans required by architectural and structural coordination.

B. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

C. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.11 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:

1. The proposed substitution does not affect dimensions shown on drawings.

2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.

3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.

4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. See Section 211000.

1.13 COORDINATION DOCUMENTS

A. See Section 211000.

1.14 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.
B. Provide services of factory-trained technicians for start-up of pumps and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Refer to other Division 21 Sections for additional requirements.

1.15 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.

B. The Contractor shall be responsible for proper instruction of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 21 to be no less than 2 hours for each piece of equipment.

1.16 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.17 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.18 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents: but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.19 CLEANING AND CLOSING
A. All work shall be inspected, tested, and approved before being concealed or placed in operation.
B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.20 WARRANTIES
A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.
B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.21 GUARANTEE
A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.
B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in Contractors work.

PART 2 - PRODUCTS

2.1 GENERAL
A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS
A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
   1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
   2. ASCE 7-05: "American Society of Civil Engineers."
   3. 2006 International Building Code (IBC)
   4. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
   6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
   7. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.
B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.

1. Adjustable Steel Clevis Hangers: MSS Type 1.
2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   a. Plate: Unguided type.
   b. Plate: Guided type.
   c. Plate: Hold-down clamp type.
5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
9. Adjustable Roller Hangers: MSS Type 43.
10. Pipe Roll Stands: MSS Type 44.
11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.

1. Steel Turnbuckles: MSS Type 13.
2. Steel Clevises: MSS Type 14.
3. Swivel Turnbuckles: MSS Type 15.
5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.

1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson
2. Steel Brackets: One of the following for indicated loading:
   b. Medium Duty: MSS Type 32.
   c. Heavy Duty: MSS Type 33.
3. Horizontal Travelers: MSS Type 58.
4. Internally Threaded Expansion Shell Anchors: By Simpson or approved equal.
5. Concrete Screw Anchors: Titen HD by Simpson or approved equal.

G. Saddles and Shields (for heat traced pipe): Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
2. Insulation Protection Shields: MSS Type 40, 18” minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
BASIC MATERIALS AND METHODS – FIRE PROTECTION

3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.

4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:

1. Metal Framing: Provide products complying with NEMA STD ML1.

2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.

3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.

4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.

5. Pipe Brackets: "HoldRite" copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1” flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each concealed valve. Use no panel smaller than 12” x 12” for simple manual access, or smaller than 24” x 24” where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.4 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 21 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:


2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.

3. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
BASIC MATERIALS AND METHODS – FIRE PROTECTION

C. Underground-Type Plastic Line Markers: Provide 6" wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

D. Valve Tags:
   1. Plastic Laminate Valve Tags: Provide 3/32" thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fasteners.
   2. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
   3. Access Panel Markers: Provide 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.
   4. Non-potable Water Tags: 1/16" thick, engraved, plastic tags as indicated on Drawings.

E. Plastic Equipment Signs:
   1. Provide 4-1/2" x 6" plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
   2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
      a. Name and plan number
      b. Equipment service
      c. Design capacity
      d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

F. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

2.5 ELECTRICAL

A. General:
   1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.

B. Quality Assurance:
   1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Low Voltage Control Wiring:
   1. General: 14 gauge, Type THHN, color coded, installed in conduit.
   2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master fitter and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER’S DIRECTIONS

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
3.3 INSTALLATION

A. Coordinate the work between the various Fire Protection Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost. Coordinate wall and ceiling work with the General Contractor, and his subcontractors in locating ceiling air outlets, wall registers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS

A. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.

B. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

C. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

D. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

F. Support sprinkler piping and gas independently of other piping.

G. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

H. Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with the NFPA):

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 1 1/4&quot;</td>
<td>5 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>1 3/8&quot; to 2&quot;</td>
<td>7 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2 7/8&quot; to 3&quot;</td>
<td>10 feet</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>4&quot; and larger</td>
<td>12 feet</td>
<td>5/8&quot;</td>
</tr>
</tbody>
</table>

I. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
   a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
   b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
   c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

J. Installation of Anchors:
1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

K. Equipment Supports:
1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.
2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

L. Adjusting:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 RAILS, PIPE PORTALS
A. Install per manufacturer's instructions.
B. Coordinate with other trades they are installed when roofing is being installed.

3.6 ELECTRICAL REQUIREMENTS
A. Fire Protection Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all devices installed under this Division of work.
B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all fire protection motors and controls in accordance with the following schedule and in accordance with equipment manufacturer’s written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA’s “Standard of Installation” to ensure that products fulfill requirements.
C. Division 21 has responsibilities for electrically powered or controlled fire protection equipment which is specified in Division 21 Specifications or scheduled on Division 15 Drawings. The specific division of responsibilities between Division 21 and 26 for furnishing or wiring this equipment is as follows:
   1. Division 21 Responsibilities:
      a. DISCONNECTS: Provide the disconnects which are part of factory wired Division
BASIC MATERIALS AND METHODS – FIRE PROTECTION

21 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.

b. CONTROLS: Division 21 Contractor is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
   1) Control relays necessary for controlling Division 21 equipment.
   2) Low or non-load voltage control components
   3) Non-life safety related valve actuators
   4) Solenoid valves, EP and PE switches

c. FIRE AND LIFE SAFETY EQUIPMENT:
   1) Fire Sprinkler System: Division 21 is responsible for providing necessary controls including flow switches and alarm bells.
   2) Specialized fire suppression systems: Division 21 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.

D. Division 26 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 21 Specifications or scheduled on Division 21 Drawings. The specific division of responsibilities between Division 21 and 26 for furnishing or wiring this equipment is as follows:
   1. Division 26 Electrical Responsibilities:
      a. DISCONNECTS: Provide all disconnects necessary for Division 21 mechanical equipment which are not provided as part of factory wired Division 21 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
      b. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.
      c. FIRE AND LIFE SAFETY EQUIPMENT:
         1) Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.
         2) Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and its controls.

   2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

   3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

   4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that “cutting-over” has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

   5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

   6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.

3.7 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after
BASIC MATERIALS AND METHODS – FIRE PROTECTION

completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
   1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
   2. Locate pipe markers as follows:
      a. Near each valve and control device
      b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern
      c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures
      d. At access doors, manholes, and similar access points which permit view of concealed piping
      e. Near major equipment items and other points of origination and termination
      f. Spaced horizontally at maximum spacing of 20’ along each piping run, with minimum of one in each room. Vertically spaced at each story transverse.

C. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6” to 8” below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16”, install single line marker.

D. Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
   1. Main control and operating valves, including safety devices
   2. Meters, gauges and similar units
   3. Compressors, chillers, and similar motor-driven units
   4. Tanks and pressure vessels
   5. Sprinkler and standpipe equipment

E. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

3.8 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including gauges, instruments, sprinkler Heads and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 210500 - Basic Materials and Methods, and other Sections in Division 21 specified herein.

1.2 DEFINITIONS

A. Pipe sizes used in this Section are nominal pipe size (NPS) specified in inches.
B. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.
C. NICET - National Institute for Certification In Engineering Technologies
D. Other definitions for fire protection systems are included in referenced NFPA standards.

1.3 DESCRIPTION OF WORK

A. The work includes designing new, providing and installing a complete and fully operable automatic sprinkler system as described in this Section of the Specification and as shown on the contract construction drawings and shall be in accordance with rules, regulations and standards as required by the following authorities having jurisdiction.
   1. State of Oregon
   2. City of Eugene
   3. Building Department
   4. Fire Prevention Division, Fire Marshal’s Office
   5. University of Oregon

B. Work to be in accordance with criteria of the following design and installation standards:
   2. National Fire Protection Association
      a. No. 13 - Sprinkler Systems
      b. No. 14 - Standpipes & Hose Systems
      c. No. 24 - Private Fire Service Mains
      d. No. 70 - National Electrical Code
      e. No. 101-Life Safety Code
   6. Underwriters Laboratories, Inc.
   7. Industrial Risk Insurance Underwriters
   8. Owner’s insurance agency

C. Work includes but is not limited to the following:
   1. Automatic Wet Type Sprinkler System
   2. Standpipes: Wet type
   3. All cutting and patching.
   4. Provide all pipe, fittings, sprinklers, valves, signs, flow switches, tamper switches, protective painting, test connections, drains and tests necessary to make the entire system complete and operative.
   5. Coordinate with plumbing contractor for capacity of all sprinkler main, test, and auxiliary drain connections.
   6. Valve tags and instruction plates shall be mounted and/or hung per local fire department requirements.
   7. All sleeves and inserts.
1.4 SUBMITTALS

A. Product Data: Submit six copies of manufacturer’s technical data and installation instructions for fire protection materials and products.
   1. Thirty days after the awarding of contract, contractor shall submit list of manufacturer’s names and model numbers for approval to architect. This list shall identify any prior approved substituted items contractor wishes to use. Do not submit technical data until list has been approved. This is mandatory.
   2. Prior to construction submit for approval items including but not be limited to the following:
      a. Coordinated layout drawings. Lettering shall be minimum 1/8” high
      b. Sprinklers and escutcheons - designating area of use
      c. Valves, valve boxes, flow switches, and tamper switches
      d. Pipe, fittings, sway bracing, inserts, anchors and hangers
      e. Inspector’s test and drain station
      f. Hose valves, pressure relief valves, and pressure reducing valves

B. Working Plans: Prepare scaled working plans for fire protection pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, and elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Indicate interface between and spatial relationship to piping and adjacent equipment. Lettering shall be minimum 1/8” high. All design work shall be done under supervision of licensed engineer.
   1. Spacing of fire sprinklers shall be coordinated with lights, air conditioning outlets, sound speakers, architectural reflected ceiling plan; obstruction from light fixtures and other architectural features; and sprinkler piping shall be coordinated with HVAC ductwork & piping, plumbing, electrical conduit, cable trays and structure prior to the installation.
   2. Drawings shall be composite type including mechanical, plumbing and lighting equipment with sprinkler and sprinkler drain piping.

C. Submittal Drawings: Submit shop drawings to Agency having jurisdiction for approval bearing engineer of record stamp. Submit six approved copies, bearing stamp and/or signature of authority having jurisdiction to the Engineer for approval.
   1. Contractor shall submit sprinkler head locations to architect for approval.
   2. Each calculation shall include legible schematic of system showing all hydraulic reference points.

D. Hydraulic Calculations: Prepare hydraulic calculations of fire protection systems. Submit to authority having jurisdiction for approval. Submit six approved copies, bearing stamp, and/or signature of Agency having jurisdiction to Owner’s representative for approval.
   1. Contractor shall submit published piping friction loss data from manufacturer with hydraulic calculations.

E. Certificate of Installation: Submit certificate upon completion of fire protection piping work, which indicates that work has been tested in accordance with NFPA 13, and also that system is operational, complete, and has no defects.

F. Maintenance Data: Submit maintenance data and parts lists for fire protection materials and products. Include this data, product data, shop drawings, approval drawings, approval calculation, certificate of installation, and record drawings in maintenance manual; in accordance with requirements of the General Conditions and of Division 01.

G. Operating and Maintenance Instructions: Provide the Owner with three sets of operating and maintenance instructions covering completely the operation and maintenance of sprinkler equipment and controls. Manual shall be assembled in a 3-ring binder and arranged in following sections:
   1. Site Utilities: Drawings showing location, size, depth of all connections, valve boxes, manholes, etc., as installed.
   2. Section No. 1: A chart tabulating all types of pipefittings, valves, and piping specialties installed in each system.

SERA Architects Inc. Package 4 - 50% Construction Documents
FIRE PROTECTION

3. Section No. 2: A chart tabulating all pressures, valve settings for fire department and sprinkler pressure reducing valves as required by S.F.F.D. Provide pressure reducing valve flow test documentation.

4. Section No. 3: Manufacturer’s brochures of all sprinkler heads.

5. Section No. 4: Tamper switches and flow switches.

6. Section No. 5: Fire Department connections.

7. Section No. 6: Reproducible copies of approved working drawings prepared to facilitate the actual installation of ductwork and piping. Drawings shall indicate location of all concealed valves, and other apparatus.


9. Section No. 8: Approval Calculations.

10. Section No. 9: Certificate of Installation.

11. Section No. 10: Guarantees.

12. The Contractor is responsible for proper instruction of Owner’s personnel for operation and maintenance of all material, equipment and apparatus provided.

1.5 DESIGN DESCRIPTION

A. This section of the specification combined with any of the contract drawings are intended as a guide to establish a basis of design for the systems required.

B. Contractor shall examine the existing building, the Architectural, Plumbing, Interior Design, Structural, Mechanical and Electrical drawings, layout and install a completely hydraulically sized sprinkler system for all existing and new areas. Space shall be provided for any valving and equipment to be used.

1. System shall start at five feet from the building exterior and extend throughout the new and existing portions of the building.

2. Contractor shall contact Owner’s insurance agency to incorporate insurer’s design requirements in this layout document. Factory Mutual shall review layout drawings and calculations. Incorporate all of their design criteria into documents.

C. The building shall be served with a wet type sprinkler system.

D. All areas shall be sprinklered as the construction progresses, including accessible pipe chases, elevator pits, etc.

E. Pressure restricting devices shall be installed on any branch outlet exceeding 100 PSI.

F. All electrical devices used for this system shall be compatible with the fire alarm system, refer to Division 26.

G. Seismic Requirement: All automatic sprinkler and standpipe system to be seismically braced and anchored for IBC Seismic Zone D, FM and NFPA 13. Submit shop drawings on methods and materials.

1. Do not use NFPA Earthquake Zone Chart.

1.6 HYDRAULIC DESIGN

A. System shall be a straight line or gridded system per NFPA No. 13 with the following exceptions:

1. For all systems the design area shall be the hydraulically most demanding rectangular area.

2. Minimum pressure for any sprinkler head shall not be less than 7 psi.

B. Fire Standpipes: Pipe schedule per IBC Chapter 9 or hydraulically calculated at 500 GPM for first standpipe and 250 GPM for each additional standpipe. Wet standpipes shall maintain 100 Psi at top of each riser.

C. Total Combined Inside & Outside Hose Allowances: Hydraulic calculations shall include an allowance for hose streams, added at the point of connection to the water supply.

D. Safety Factor: 10 Psi, or 10 percent of static and residual pressure, whichever is greater.
FIRE PROTECTION

E. Light Hazard Areas: Water density of 0.10 GPM per square foot calculated for an area of 1500 square feet in the most remote location.

F. Ordinary Group I Hazard Areas: Water density of 0.15 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.

G. Ordinary Group II Hazard Areas: Water density of 0.20 GPM per square foot calculated for an area of 1500 square feet in the most remote locations.

H. Head spacing shall not exceed the limits described in NFPA Pamphlet No. 13.
   1. Light Hazard: 225 sq.ft. (for smooth ceiling)
   2. Ordinary Hazard: 130 sq. ft.
   3. Extra Hazard: 100 sq. ft.

I. Maximum floor areas protected by any one sprinkler system riser:
   1. Light Hazard: 52,000 sq.ft.
   2. Ordinary Hazard: 52,000 sq.ft.

J. Flow Data: Contractor is to verify flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow.

1.7 RELATED WORK SPECIFIED ELSEWHERE

A. Section 210500: Basic Materials and Methods

B. Division 26: Electrical. Coordinate for electrical wiring of detectors, flow alarm switches, tamper switches, fire alarm bell connection by life safety section for remote monitoring. All electrical devices used for this system shall be compatible with the fire alarm system.

C. Division 09: Finishes.

D. Division 02: Existing Conditions. Coordinate with General Contractor for excavation for the underground water supply system.

E. Coordination with Plumbing for drain

1.8 QUALITY ASSURANCE

A. The Contractor for the fire protection installation shall be duly qualified Fire Protection Contractor, experienced and regularly engaged in the installation of fire protection systems with a license classification of C-16. Where local authorities require additional licensing of the Fire Protection Contractor, and/or workmen, such a license shall be mandatory for a prospective Contractor.
   1. Contractor is to verify flow data (static pressure, residual pressure and GPM flowing) available at site and provide design for available pressure and flow.
   2. The Fire Protection contractor shall be the Engineer of Record for the automatic sprinkler and standpipe system.
   3. Permits - The Fire Protection Contractor shall obtain permits for the installation or construction as required for approval and installation of the fire protection system. The Fire Protection Contractor shall submit working plans to the authorities having jurisdiction to obtain approval.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01. Handle components carefully to prevent damage, denting, and scoring. Do not install damaged components. Damaged components shall be replaced with new components.

B. Store/protect products under provisions of Division 01. Store components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage.

1.10 GUARANTEE

A. Provide a one-year (12 months) guarantee under provisions of Division 01. The guarantee shall include parts, shipping, labor, travel costs, living expenses, required fees, and any other associated
FIRE PROTECTION

cost or expense to repair or replace products or systems. The guarantee period is to begin on the date of acceptance of the fire protection installation by the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products to be commercial grade, new and of the manufacturer's latest design model. Products manufacturers outside of North America will not be accepted without written approval from engineer prior to submission of bid.

B. All products to be UL listed and/or FM approved, except for items, which are not required to be listed by code.

C. All products shall be delivered and stored in original containers. Containers shall be clearly marked or stamped with manufacturer's name and rating.

D. The following items to be included but specified under Section 210500: Basic Materials and Methods.
   1. Hangers and supports
   2. Escutcheons plates, flashings and sleeves
   3. Access panel and doors
   4. Identification markers and signs
   5. Expansion compensators and flexible connectors
   6. Anchors and seismic restraints
   7. Excavation and backfill

E. Coordination: All piping and pre-action system in basement data center area will be required to be fully coordinated with data center design team prior to installation.

2.2 UNDERGROUND PIPE COATING:

A. All underground ferrous piping shall be covered with:
   1. Either two coats of 10 Mill Scotch Wrap No. 51, or with;
   2. "XTRU-COAT" prefabricated extruded cover with joints sealed with two coats of 10 Mill Scotch Wrap #51.
   3. Or approved equal

2.3 THRUST BLOCKS

A. Provide thrust blocks at changes in pipe direction, changes in pipe sizes, dead-end stops and at valves.

B. Calculate area of undisturbed earth of thrust block based on actual soil conditions and water test pressure of 200 Psi.

C. Concrete and reinforcing steel shall be as specified in Division 03 and 05. All concrete shall be Class A, unless specified otherwise.

D. Miscellaneous nuts and bolts shall be stainless steel.

2.4 RODS AND CLAMPS

A. Socket clamps shall be stainless steel; four bolt type, equipped with stainless steel socket clamp washers and nuts Grinnell Fig. 595 and 594, Elcen Fig. 37 and 37X, or equal.

B. Rods shall be stainless steel, 3/4" diameter.

2.5 PIPE AND FITTINGS - ABOVE GROUND

A. General: The piping products listed below by manufacturer's name and model numbers are the only acceptable materials listed for this project. Substitutions of pipe must be submitted and approved in writing by the architect prior to bid. No copper pipe shall be allowed in the wet fire sprinkler system.
FIRE PROTECTION

B. Piping or fittings that show substantial rust or breaks in coating will be removed and replaced.

C. Allied Tube & Conduit: Schedule 40 black steel, ASTM A-135 stamped on pipe, UV cured acrylic finish; Stockham, Grinnell or Warwick Class 150 threaded malleable, ASTM A197, ASTM A126, or Victaulic roll-grooved fittings and couplings, only.

D. Allied Tube: Scheduled 10 black steel pipe, ASTM A-135 stamped on pipe, UV cured acrylic finish; Victaulic roll-grooved fittings and couplings.

E. Shop-weld thread-o-lets may be used in lieu of tee fittings, but field (site) welding will not be permitted.

F. Mechanical Couplings: Victaulic grooved couplings style 07, 75 or 77, or equal by Gruvlok.

G. Mechanical Tees: Victaulic style 920, Gruvlok. U-bolt mechanical tees are not acceptable.

H. Flexible sprinkler connector for suspended ceiling sprinkler application: Flexhead or equal Factory Mutual approved system.

I. Use rigid couplings where flexibility is not required or provide necessary sway bracing.

J. Prohibited Piping and Fittings: Copper pipe, CPVC pipe, pipe less than schedule 40 for threaded or less than schedule 10 for roll grooving; Super 40 “Dyna-Flow”, “Dyna-Thread”, “Fireflow”, XL, Thinwall, ”Eddylyte” by Bullmoose and Threadable Lightwall pipe are not allowed. POZ-LOK, U-bolt Victaulic style 921 mechanical tees, Victaulic style 99 Roust-A-Bout, Victaulic style 90 Plainlock, Hooker style fitting, quick disconnect, boltless, snap-joint, field drilling or welding of any main or branch lines, and any device specifically prohibited by the local authority having jurisdiction is not allowed. No unions shall be permitted for any size pipe. Plain end fittings are not allowed.

2.6 SPRINKLER HEADS - GENERAL

A. Sprinkler heads shall be regular automatic closed-type heads of ordinary degree temperature rating except that sprinkler heads installed in the vicinity of heating equipment or in special occupancy areas shall be of the temperature rating as described in NFPA No. 13.

B. Provide quick response heads in all new light hazard occupancies.

C. Provide corrosion-resistant sprinkler heads where they are exposed to weather, moisture or corrosive vapors.

D. The Contractor shall furnish spare heads. The heads shall be packed in a suitable container and shall be representative of, and in proportion to, the number of each type and temperature rating head installed. In addition to the spare heads, the contractor shall furnish not less than two special sprinkler head wrenches. Refer to NFPA 13 section; “Stock of Spare Heads”.

2.7 SPRINKLER HEADS AND ESCUTCHEONS

A. Sprinkler heads installed shall be upright or pendant, as conditions require, and shall be of the following type and finish for the areas designated. Unless otherwise specified, sprinklers shall be small frame type, center bulb capsule for finished areas, fusible link for unfinished areas, and ½” orifice. Extended coverage sprinkler heads are not allowed.

<table>
<thead>
<tr>
<th>Building Area</th>
<th>Sprinkler Head</th>
<th>Sprinkler Finish</th>
<th>Escutcheon Finish</th>
<th>Temp. Deg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfinished Retail, &amp; Office, Garage &amp; Mechanical Rooms</td>
<td>Upright/Pendant</td>
<td>Brass</td>
<td>None</td>
<td>165°F</td>
</tr>
<tr>
<td>Electrical, Telephone &amp; Switchgear Rooms</td>
<td>Upright</td>
<td>Brass</td>
<td>None</td>
<td>286°F</td>
</tr>
</tbody>
</table>
FIRE PROTECTION

<table>
<thead>
<tr>
<th>Building Area</th>
<th>Sprinkler Head</th>
<th>Sprinkler Finish</th>
<th>Escutcheon Finish</th>
<th>Temp. Deg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finished Ceilings</td>
<td>Semi-recessed Pendant</td>
<td>White</td>
<td>White</td>
<td>165°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Coverplate</td>
<td>165°F</td>
</tr>
<tr>
<td>Concealed Pendant</td>
<td>Brass</td>
<td></td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>Soffit</td>
<td>Flush Sidewall</td>
<td>White</td>
<td>White</td>
<td>165°F</td>
</tr>
<tr>
<td>Sidewall</td>
<td>Horizontal Sidewall</td>
<td>Brass</td>
<td>None</td>
<td>165°F</td>
</tr>
</tbody>
</table>

B. Manufacturer: TYCO only.

2.8 VALVING
A. 2" or Smaller:
1. Control Valve: OS&Y rising stem type gate valve bronze body, bonnet and disc, copper alloy stem, threaded ends, 175 PSI WOG min. Provide with tamper switch.
2. Check Valve: Swing check type with bronze body, cap and disc, threaded ends, 175 PSI WOG min.
3. Drip Valve: 3/4", cast brass automatic ball drip type, threaded ends, 175 PSI WOG min.
4. Testing Valve: 1-1/4", test and drain, sight glass, ½" test orifice, lever operated, 300 psi WOG. Drain to mop sink or drain riser.
5. Main Drain Valve: 2", angle gate valve, bronze body, copper alloy stem, threaded ends, 175 psi WOG. Drain to mop sink or drain riser.

B. 2-1/2" or Larger:
1. Control Valve: Lug type wafer valve with tamper switch, ductile iron body, nickel plated ductile iron disc, stainless steel stem and Buna-N seat, 175 PSI WOG min.
2. Control Valve: OS&Y rising stem type gate valve, cast iron body and bonnet, bronze stem, seat and disc, flanged ends, 175 PSI WOG min. Provide with tamper switch.
3. Check Valve: Swing check type with cast iron body, bolted cap and disc, flanged ends, 175 PSI WOG min.
4. Manufacturer: Grinnell, Stockham, Milwaukee, Mueller, Kennedy, Elkart or AGF.

2.9 BACKFLOW PREVENTER
A. Provide listed backflow prevention device as required by local codes and ordinances. Backflow prevention devices installed in the vertical position shall be approved for that orientation.

B. Double check detector check valve assembly: Epoxy coated, ductile iron construction, 175 Psig working pressure, complete with two spring loaded "Y" type check valves, "Y" strainer with hose bibb on suction side of assembly, two OS&Y gate valves, test cocks, bypass water meter and bypass doublecheck. Febco #856-DCDA, Conbraco or approved equal.

2.10 WET AND DRY SPRINKLER ALARM CHECK VALVES
A. Contractor shall provide completely engineered wet alarm check valve, retarding chamber, and trim assembly for each floor. Viking #H-2, Tyco or Reliable.

B. Contractor shall provide completely engineered dry alarm check valve, air supply, and trim assembly for each stair standpipe. Tyco DPV-1, Viking, or Reliable.

2.11 VALVE BOXES
A. Cast iron valve boxes for shutoff valves buried in ground shall be complete with bellbottoms, extension piece, top and cover. Boxes shall be suitable for the types of valves with which they are used. All valve boxes shall have a concrete collar flush with grade.
FIRE PROTECTION

B. Lids shall have the applicable letters embossed upon the top surface. Tagging shall match existing lids.

C. Manufacturer: Tyler, ITT Grinnell, or equal.

2.12 INTEGRAL INSPECTORS ALARM TEST AND SYSTEM DRAIN

A. Combination system drain and visible orifice insert/sight glass for testing system alarm; with screwed or grooved inlet and outlet connections, Malleable iron hand wheel, EPDM valve seats, maximum working pressure 300 Psi, 1/2” orifice insert, Bronze housing, UL listed and FM Approved. Victaulic TestMaster II style 720, or approved equal.

B. Water pressure gauge, range 0-300 Psi, in 5 Psi increments, brass case - 3-1/2” diameter, 1/4” NPT male pipe connection, UL listed. Locate pressure gage on riser per code. Star Sprinkler, Ashcroft or approved equal.

C. Pressure gauge test valve, brass 1/4” screwed ends, 300 Psi WOG. United or approved equal.

D. All relief, main, auxiliary and equipment drains shall be routed separately to floor drain or air gap fitting (by plumbing).

2.13 TAMPER SWITCHES

A. Switch shall be mounted so as not to interfere with normal operation of the valve and be adjusted to operate when handle of valve has traveled more than one-fifth the distance of its normal operating position. Electrical Contractor shall provide conduit from switch to fire alarm panel.

B. Housing shall be of aluminum, acid-treated, primed and finished in baked red enamel. Removal of housing shall cause switch to operate. Inside shall be single pole, double throw micro switch with connection for electrical conduit.

C. Install on all control valves.

D. Manufacturer: Potter-Electric, Notifier, Ellenco, or Simplex.

2.14 EXTERIOR ALARM

A. Electric bell, 10” diameter, U.L. listed, 120 VAC, 99 dB at 10 FT; Potter model PBA12010 or equal.

B. Provide signage stating “IF RINGING CALL 911”

C. Electric Horn: Potter-Electric, Ellenco, Notifier, or Simplex weatherproof, 120 VAC.

2.15 FIRE DEPARTMENT HOSE VALVES

A. Fire Department Valves: 2-1/2” brass construction female to male angle valve with cap and chain, rough chrome finish and mounted 48” above finished floor.

B. Manufacturer: Croker, Elkhart, Powhattan Brass, Potter-Roemer or Zum.

2.16 ROOF MANIFOLD

A. 6” x 2-1/2” x 2-1/2” straight pattern cast brass roof manifold, Croker Model No. 294 or approved equal.

2.17 PRE-ACTION SYSTEM

A. System Components
   1. Deluge Valve
   2. Deluge Valve Trim Including:
      a. Test Drain Valve
      b. Auxiliary Drain Valve
      c. Drain Cup
      d. Drip Check
      e. Alarm Test Shut Off Valve
      f. Strainer Orifice Check Valve
FIRE PROTECTION

g. Pressure Operated Relief Valve
h. Priming Valve
i. Emergency Release
j. Priming Pressure Gauge and Valve
k. Water Supply Pressure Gauge and Valve

3. Water Flow Alarm Trim:
a. Alarm Pressure Switch

4. Riser Valves:
a. Water Supply Control Valve
b. Rubber Seat Check Valve
c. System Main Drain Valve

5. System Air Supply Trim:
a. System Pressure Gauge and Valve
b. Soft Seat Check Valve
c. Air Supervisory Pressure Switch
d. Air Supply Control Valve
e. Dry System Air Supply

6. Release Trim:
a. Strainer
b. Solenoid Valve

PART 3 - EXECUTION

3.1 GENERAL
A. This system to be installed by an experienced firm regularly engaged in the installation of automatic sprinkler system as specified by the requirements of the Specifications.

3.2 PERFORMANCE OF WORK
A. Examine areas and conditions under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings and in accordance with NFPA Pamphlet No. 13 and 14.
B. Work to start immediately after authorization has been given to proceed so that the overall progress of the construction is not delayed.
C. Coordinate with other trades as necessary to properly interface components of the sprinkler system.
D. Follow manufacturer's directions and recommendations in all cases.
E. The omission from the drawings or Specifications of any details of construction, installation, materials, or essential specialties shall not relieve the Contractor from furnishing the same in place for a complete system.

3.3 TEMPORARY FIRE PROTECTION
A. Provide all temporary valving, piping, Siamese connections and other components as directed by the fire agency office during all phases of construction.

3.4 INSTALLATION - GENERAL
A. Fire protection system shall be installed in accordance with the approved Drawings. The finished ceiling is not to be erected until all fire protection piping has been installed, tested, and inspected. Sprinkler heads located in the electrical equipment, elevator, or similar rooms shall be furnished with deflectors to prevent water spray on equipment.
B. The arrangement of all pipes shall conform to all architectural requirements and field conditions, shall be as straight and direct as possible, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be permitted only where required to permit the pipes to follow the walls. Standard fittings shall be used for offsets. All risers shall be erected plumb and true, shall be parallel with the walls and other pipes, and shall be neatly spaced. All work
FIRE PROTECTION
shall be coordinated with HVAC, Plumbing, Electrical and Structural work in order to avoid interference and unnecessary cutting of floors or walls.

C. All sprinkler heads to be installed in ceilings throughout the scope of work building as listed in Section 2.6. All areas without ceilings shall have rough brass upright or pendent heads as shown on drawings.

D. Sprinkler heads in all finished areas are to be installed on a true axis line in both directions, with maximum deviation from the axis line of 1 inch plus or minus and shall be plus or minus 1" within center of tile. At the completion of the installation, if any heads are found to exceed the above-mentioned tolerance, they shall be removed and reinstalled.

E. No pipes or other apparatus shall be installed so as to interfere in any way with full swing of doors.

F. The arrangement, positions, and connections of pipes, drains, valves, etc., shall be as required by NFPA Pamphlet #13 for all areas to be sprinklered. However, the right is reserved by the Architect to change the location of any item to accommodate conditions, which may arise during progress of the work, without additional compensation for such changes provided that no additional heads are required prior to the installation of the work.

G. Where required, piping shall be installed concealed in building construction, or though steel beams, to obtain adequate head room.

H. All pipe throughout the job shall be reamed smooth before being installed. Pipe shall not be split, bent, flattened, or otherwise injured either before or during installation.

I. Provide protective pans under pipes passing over high voltage electrical bus duct or switchgear equipment. The pan shall be constructed of 12 gauge black iron with a 6 inch lip, the corners being welded to make the pans watertight. Each pan shall be given three coats of Rust-Oleum paint and shall be supported by pipe hangers. The pan shall drain clear of the bus duct or switchgear.

J. All pipe interiors shall be thoroughly cleaned of foreign matter before installation, and shall be kept clean during installation by plugging or other approved means. Piping shall be covered with visqueen during storage. Piping that shows signs of rusting will be removed from job site and replaced.

K. Field Connections: Any modifications to system required by field conditions, physical equipment changes or compliance with code regulations shall be made promptly without cost to Owner.

L. Interference: No piping or sprinkler devices shall interfere with the operations of any door, window or mechanical and electrical systems. No part of this system shall visibly be installed in the physical parameter of any window. Sprinkler mains and branch piping shall not interfere with existing or future ceiling, light fixtures and HVAC diffusers.

M. Threaded Pipe: Threads shall be clean cut, standard and tapered. Threads shall be made up using flaked graphite and lubricating oil, piping compound or Teflon tape applied to the male threads only.

N. Grooved Pipe: Installation shall be as prescribed in the Victaulic Piping Manual only. Holes in the piping are to be made in the fabrication shop, not at the job site. Contractor shall provide at the project site a sample of each type of coupling (threaded, standard grooved coupling and mechanical type), showing complete assembly with pipe connections.

O. Keep all pipe and other openings closed to prevent entry of foreign matter. Cover all equipment and apparatus to protect against dirt, water, chemical or mechanical damage, before and during construction period. Restore to original condition all apparatus and equipment damaged prior to final acceptance, including restoration of damaged shop coats of paint.

P. Location of sprinkler piping is critical.
1. Where ceiling space is at a minimum under beams location of ductwork takes precedence, coordinate accordingly.
2. Include in base bid (3) two-hour coordination meetings with Owner, Architect, and Engineer for coordination of sprinkler pipe routing.
3. Coordinate beam and shear wall penetrations with Structural Engineer. Obtain written approval for all beam penetrations from Structural Engineer.

Q. Elevator Pits: For hydraulic elevators provide sprinkler heads in elevator pits per elevator code. Provide control valve with tamper switch to each pit area. Coordinate with Division 26 Fire Alarm System.

R. Tracer wire shall be wrapped and taped to non-metallic underground piping at maximum 20 foot intervals.

3.5 SLEEVES AND FLASHINGS

A. Wherever pipes are exposed and pass through walls, floors, partitions or ceilings, they shall be fitted with chromium plated steel escutcheons held in place with setscrews. Care shall be taken to protect the escutcheons during the course of construction.

B. Penetrations through fire rated walls and floors shall be sealed with listed mastic of similar fire rating.

3.6 HANGERS, INSERTS, SUPPORTS, AND SWAY BRACING

A. Hangers and supports shall be installed per NFPA #13 sections on Hangers and Protection of Piping Against Damage Where Subject to Earthquake. Provide restraint from movement at end sprinkler on branch line per NFPA 13.

B. Bending of threaded hanger rod is not allowed. All powder driven anchor pins in concrete are not allowed.

3.7 SAFETY TESTING & VERIFICATION

A. Flush, test, and inspect sprinkler piping systems according to NFPA 13 Chapter "System Acceptance."

B. Provide NFPA 13 Contractor's Material & Test Certificate Form 85A for above ground piping and Form 85B for underground piping.

C. Provide manpower to test the function and performance of all Life Safety System components and devices per floor and per zone basis in accordance with the local requirements.

3.8 IDENTIFICATION

A. In addition to the requirements of Section 210500, provide pipe markers every 20 feet, once in every room, and at each building level traversed, minimum.

B. Provide hydraulic design data nameplates on the riser of each sprinkler system in accordance with NFPA 13

C. Equipment such as valves, drains, etc., shall be provided with signs that identify type of equipment and service. The tag shall be securely fastened to the handle or spindle of the valve by a brass chain. Furnish four schedules of valves so tagged. There shall also be furnished four diagrammatic charts showing schematically the complete sprinkler system with major control valves and numbers thereof. One set of Schedules and charts shall be mounted in glazed frames located where directed.

3.9 AS-BUILT RECORD DRAWINGS AND CERTIFICATION

A. As-built Record Drawings are to be kept up-to-date and the Master Copy kept at the job site. Prior to final acceptance of work being approved, these drawings are to be turned over to the Owner's Representative for approval.

B. Written certification from the insuring agents, and authorities having jurisdiction that the tests were satisfactory.

C. After installation is complete and tests satisfactorily approved, deliver test certificates and approval by the local Fire Authorities and the FMA to the architect. Final acceptance of sprinkler/standpipe
FIRE PROTECTION

system by Owner’s Representative shall be contingent upon receipt of certificate and approval from authorities having jurisdiction and for the delivery of final As-Built Drawings.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Plumbing Sections specified herein.

1.2 SCOPE OF THIS SECTION
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
1. Compliance with all codes and standards applicable to this jurisdiction
2. Shop Drawings for Equipment
3. Coordination Documents
4. Record Drawings
5. Start-up Service and Building Commissioning
6. Instruction, Maintenance, and O & M Manuals
7. Work associated with Delivery, Storage, and Handling of products
8. Work associated with provision of Temporary Facilities
9. Preparation of Posted Operating Instructions
10. Meeting Project Safety and Indemnity requirements
11. Proper Cleaning and Closing
12. Supplying proper Warranty information
13. Supply specified Guarantee documentation
14. Design and provision of Supports and Anchors
15. Pipe Portals
16. Equipment Rails
17. Access Panels and Doors
18. Identification Markers
19. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK
A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete plumbing systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, existing installation, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Project involves interface with existing building and site systems, effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.4 DESCRIPTION OF BID DOCUMENTS
A. Specifications:
1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.
B. Drawings:
1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
2. Before proceeding with work check and verify all dimensions.
3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
4. 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.
5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

1.5 DEFINITIONS
A. "Above Grade": Not buried in the ground and not embedded in concrete slab on ground.
B. "Actuating" or "Control" Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
C. "Below Grade": Buried in the ground or embedded in concrete slab on ground.
D. "Concealed": Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
E. "Connect": Complete hook-up of item with required service.
F. "Exposed": Not installed underground or "concealed."
G. "Furnish": To supply equipment and products as specified.
H. "Indicated," "Shown" or "Noted": As indicated, shown or noted on Drawings or Specifications.
I. "Install": To erect, mount and connect complete with related accessories.
J. "Motor Controllers": Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.
K. "Piping": Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
L. "Provide": To supply, install and connect as specified for a complete, safe and operationally ready system.
M. "Reviewed," "Satisfactory" or "Directed": As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.
N. "Rough-In": Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
O. "Shall": An exhortation or command to complete the specified task.
P. "Similar" or "Equal": Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
Q. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
R. "Typical" or "Typ": Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.
S. "Will": A desire to complete the specified task. Allows some flexibility in application as opposed to "Shall."

T. "Wiring": Raceway, fittings, wire, boxes and related items.

U. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 22 Plumbing sections included herein.

B. Division 02: Existing Conditions. Coordinate with Civil Engineer.
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.
   1. All concrete work for Plumbing Division shall be included in Division 22 under the appropriate Sections and shall include:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.
      c. Coordination of floor drain and floor sink installations in sloped floors.

D. Division 05:

E. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal
   2. Sealants and caulking
   3. Firestopping

F. Division 09: Finishes:
   1. Division 22 installers shall perform all painting, except where specifically stated otherwise in Division 09.
   2. Painting of all exposed steel, piping, insulation, equipment and materials.
   3. Paint all exposed gas piping, interior and exterior to the building, yellow.

G. Division 26: Electrical is related to work of:
   1. Power connections to all plumbing equipment
   2. Life safety provisions

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 22 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All plumbing work shall comply with the Americans with Disabilities Act (ADA).

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
      b. 2010 Oregon Mechanical Specialty Code (OMSC) based on 2009 International Mechanical Code (IMC) and International Fuel Gas Code (IFGC) with State
BASIC MATERIALS AND METHODS - PLUMBING

Amendments

C. 2011 Oregon Plumbing Code (OPC) based on 2009 Uniform Plumbing Code (UPC) with State Amendments
d. Oregon Fire Code (Based on the International Fire Code)
e. National Electric Code (NEC) with State Amendments

2. Local, city, county and state codes and ordinances
3. Local Bureau of Buildings
4. Local Health Department
5. Local and State Fire Prevention Districts
6. State Administrative Codes

G. Provide in accordance with appropriate referenced standards of the following:
1. NFPA - National Fire Protection Association
2. CSA - Canadian Standards Association
3. ANSI - American National Standards Institute
4. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
5. ASME - American Society of Mechanical Engineers
6. ASTM - American Society for Testing Materials
7. AWS - American Welding Society
8. AWWA - American Water Works Association
9. FM - Factory Mutual
10. MSS - Manufacturer's Standardization Society
11. NEMA - National Electrical Manufacturer's Association
12. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
13. UL - Underwriter's Laboratories
14. ADA - Americans with Disabilities Act
15. ETL - Electrical Testing Laboratories
16. ASSE - American Society of Sanitary Engineers
17. PDI - Plumbing and Drainage Institute
18. IAPMO - International Association of Plumbing and Mechanical Officials
19. CISPI - Cast Iron Soil Pipe Institute

1.8 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375”), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.

B. Current Models. All work shall be as follows:
1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 22, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.
B. Review contract documents and technical specifications for extent of new work to be provided.
C. Provide and pay for all permits, licenses, fees and inspections.
D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.
E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.

F. Coordinate mechanical equipment and materials installation with other building components.

G. Verify all dimensions by field measurements.

H. Arrange for chases, slots, and openings in other building components to allow for plumbing installations.

I. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

J. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

K. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.

L. Where mounting heights are not detailed or dimensioned, install plumbing services and overhead equipment to provide the maximum headroom possible.

M. Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

N. Coordinate the installation of plumbing materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

O. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

P. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

Q. All materials (such as insulation, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

R. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

S. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.10 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all plumbing work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.
BASIC MATERIALS AND METHODS - PLUMBING

B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the mechanical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Electrical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.11 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.

C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.

D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.13 UNIT PRICING SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to architect for preliminary approval a complete list of manufacturer’s names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
1. Indicate substituted items.
2. Identify test and balancing agency.
3. Identify independent testing laboratory for water analysis.

C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.

D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.14 COORDINATION DOCUMENTS

A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all piping and all system appurtenances with other trades. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The Drawings shall be prepared as follows:
1. The Sheet Metal (Mechanical) Contractor shall prepare Drawings to an accurate scale of 1/4” = 1'-0” or larger, on reproducible media sheets (vellum) or AutoCAD disks. Obtain reproducibles or AutoCAD files of the HVAC design from the Architect, or Engineer, at cost plus. Drawings are to be same size as Contract Drawings and shall indicate location, size and elevation above finished floor, of all HVAC equipment, ductwork, and piping.
2. The Plumbing Contractor shall obtain reproducible plans or AutoCAD disks from the Mechanical Contractor, and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.
3. The Fire Protection Contractor shall obtain reproducible plans or AutoCAD disks with the detailed mechanical and plumbing work shown. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
4. Plans are to incorporate all addenda items and change orders.
5. Distribute plans to all trades and provide additional coordination as needed.

C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

D. Provide means of access to all valves, controllers, operable devices, and other apparatus that may require adjustment or servicing.

E. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Architect of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.
1.15 RECORD DRAWINGS

A. Before commencing installation, obtain an extra set of prints from Architect, marked "Record." Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,
   1. Obtain a clean set of reproducibles from the Architect or Engineer, at cost plus, and transfer the revisions to these reproducibles in a neat and orderly fashion.
   OR
   2. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.

B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.

C. Mark Drawings to indicate revisions to piping, size, and location both exterior and interior; including locations of other control devices, valves, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Refer also to Special Conditions in Division 01 for full scope of requirements.

1.16 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of temperature controls, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Refer to other Division 22 Sections for additional requirements.

1.17 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.

B. The Contractor shall be responsible for proper instruction of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 22 to be no less than 2 hours for each piece of equipment.

1.18 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
BASIC MATERIALS AND METHODS - PLUMBING

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.19 TEMPORARY FACILITIES

A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.

1.20 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.21 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.22 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.23 WARRANTIES

A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.

B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.24 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:

1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
2. ASCE 7-05: "American Society of Civil Engineers."
3. 2006 International Building Code (IBC)
4. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
6. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.

1. Adjustable Steel Clevis Hangers: MSS Type 1.
2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   a. Plate: Unguided type.
   b. Plate: Guided type.
   c. Plate: Hold-down clamp type.
5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
9. Adjustable Roller Hangers: MSS Type 43.
10. Pipe Roll Stands: MSS Type 44.
11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and
BASIC MATERIALS AND METHODS - PLUMBING

cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
   1. Steel Turnbuckles: MSS Type 13.
   2. Steel Clevises: MSS Type 14.
   3. Swivel Turnbuckles: MSS Type 15.
   5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
   1. Concrete Inserts: MSS Type 18 or Blue Banger Hanger by Simpson
   2. Steel Brackets: One of the following for indicated loading:
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   3. Horizontal Travelers: MSS Type 58.
   4. Internally Threaded Expansion Shell Anchors: By Simpson or approved equal.
   5. Concrete Screw Anchors: Titen HD by Simpson or approved equal.

G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
   1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
   2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
   3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.
   4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:
   1. Metal Framing: Provide products complying with NEMA STD ML1.
   2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
   3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand by volume, with minimum amount of water required for placement and hydration.
   4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
   5. Pipe Brackets: "HoldRite" copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 PIPE PORTALS
A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
   1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
   2. Insulation to be 1-½” thick, 3 lb density rigid fiberglass.
   3. Curb to have a raised 3” (minimum), 45° cant.
   4. Curb to have 1-1/2” x 1-1/2” wood nailer (minimum).
   5. Curb height to be 8” (minimum) above roof deck.
   6. Cant shall be raised to match roof insulation thickness.
   7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.
   8. Manufacturer: Roof Products Systems or Pate.

2.4 EQUIPMENT/PIPING RAILS
A. Where equipment/pipe rails are not provided by other sections of Specification, provide prefabricated reinforced equipment rails as required for support of equipment and piping. Field built curbs are acceptable alternatives - provide detail of construction for review.

B. Standard equipment rail, unless otherwise noted, shall be constructed as follows:
   1. Construct of heavy gauge galvanized steel with continuous welds on shell seams.
   2. Provide internal reinforcing supports welded as required to meet application requirements.
   3. Equipment rails to have raised 3” (minimum), 45° cant.
   4. Equipment rails to have 1 1/2” x 1 1/2” wood nailer (minimum) and counterflashing.
   5. Equipment rail height to be 6” (minimum) above roof deck.
   6. Cant shall be raised to match roof insulation thickness.
   7. Equipment rails to be constructed to meet equipment size and weight requirements. Provide tapered rails to match roof pitch where required.
   8. Manufacturer: Pate, Vent Products, Thy Curb or Roof Products Systems.

2.5 ACCESS PANELS AND ACCESS DOORS
A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1” flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve. Use no panel smaller than 12” x 12” for simple manual access, or smaller than 24” x 24” where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.6 IDENTIFICATION MARKERS
BASIC MATERIALS AND METHODS - PLUMBING

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 22 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:
   2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
   3. Insulation: Furnish 1” thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2” beyond each end of plastic pipe marker.
   4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Underground-Type Plastic Line Markers: Provide 6” wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

D. Valve Tags:
   1. Brass Valve Tags: Provide 1 1/2” diameter 19-gaugh polished brass valve tags with stamp-engraved piping system abbreviation in 1/4” high letters and sequenced valve numbers 1/2” high, and with 5/32” hole for fastener. Fill tag engraving with black enamel. Provide what building the valve serves (main, floor, area, room, etc). Provide valve status: Normally open (OPEN) or normally closed (CLOSED) Provide piping system the valve serves.
   2. Plastic Laminate Valve Tags: Provide 3/32” thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4” high letters and sequenced valve number 1/2” high, and with 5/32” hole for fasteners.
   3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
   4. Access Panel Markers: Provide 1/16” thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8” center hole to allow attachment.
   5. Non-potable Water Tags: 1/16” thick, engraved, plastic tags as indicated on Drawings.

E. Plastic Equipment Signs:
   1. Provide 4-1/2” x 6” plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.
   2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
   3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
      a. Name and plan number
      b. Equipment service
      c. Design capacity
      d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

F. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

2.7 ELECTRICAL

A. General:
BASIC MATERIALS AND METHODS - PLUMBING

1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.

2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein. VFD by Electrical if required.

3. Set and align all motors and drives in equipment specified herein.

4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.

5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment. Cover shall extend to below the bottom of the shaft and coupling, and shall meet the requirements of the State Industrial Safety Regulations.

6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

B. Quality Assurance:

1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:

1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.

2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors ½ HP or larger shall be rated for 208 or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than ½ HP shall be rated for 120 volt, single phase operation.

4. Temperature Rating: Motor meets class B rise with class F insulation.

5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.

   a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
   b. VFD driven motors. To be provided rated for inverter duty (NEMA Standard MG-1, Part 31) and equipped with a shaft grounding device or as an insulated bearing motor.
   c. Bearings:
      1) Ball or roller bearings with inner and outer shaft seals.
      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
      4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
      5) Enclosure Type:
         a) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
         b) Guarded drip-proof motors where exposed to contact by employees or building occupants.
         c) Weather protected Type I for outdoor use, Type II where not housed.
   d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
   e. Noise Rating: "Quiet."
BASIC MATERIALS AND METHODS - PLUMBING

f. Efficiency:
   1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
   2) Motors shall meet the NEMA premium efficiency standard.

g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:
   1. Motor Starter Characteristics:
      a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
      b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
   2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).
   3. Magnetic Starters:
      a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
      b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
      c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
      d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
      e. Externally operated manual reset.
      f. Under-voltage release or protection for all motors over 20 hp.
   4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:
   1. General: 14 gauge, Type THHN, color coded, installed in conduit.
   2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:
   1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
   2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS
BASIC MATERIALS AND METHODS - PLUMBING

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION

A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS

A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.

B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. Support gas independently of other piping.

H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

I. Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with the SMACNA Seismic Restraint Manual using a safety factor of five):

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” to 1 1/4”</td>
<td>6 feet</td>
<td>3/8”</td>
</tr>
<tr>
<td>1 1/2” and larger</td>
<td>10 feet</td>
<td>1/2”</td>
</tr>
</tbody>
</table>

Package 4 - 50% Construction Documents
### BASIC MATERIALS AND METHODS - PLUMBING

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 2&quot;</td>
<td>6 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2 ½&quot; and larger</td>
<td>8 feet</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

### J. Sloping, Air Venting, and Draining:
1. Slope all piping as specified and as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in the direction of flow as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Inclination</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>Down</td>
<td>1&quot; per 100'</td>
</tr>
<tr>
<td>Heating Water</td>
<td>Up</td>
<td>1&quot; per 40'</td>
</tr>
<tr>
<td>Soil and Waste</td>
<td>Down</td>
<td>1/4&quot; per foot (1/8&quot; per foot)</td>
</tr>
<tr>
<td>Storm Water</td>
<td>Down</td>
<td>1/4&quot; per foot (1/8&quot; per foot)</td>
</tr>
<tr>
<td>Sanitary Vent</td>
<td>Up (towards roof terminal)</td>
<td>1/4&quot; per foot (1/8&quot; per foot)</td>
</tr>
</tbody>
</table>

2. Provide eccentric reducers in horizontal piping for all sizing changes:
3. Provide drain valves and hose adapters at all low points in piping.
4. Provide vents at all high points in water piping.

### K. Provisions for Movement:
1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
   a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
   b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold water piping, install shields or inserts.
   c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

### L. Installation of Anchors:
1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

### M. Adjusting:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

### 3.5 ELECTRICAL REQUIREMENTS

A. Plumbing Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all plumbing, motors and controls in accordance with the following schedule and in...
BASIC MATERIALS AND METHODS - PLUMBING

accordance with equipment manufacturer’s written instructions and with recognized industry
practices, and complying with applicable requirements of UL, NEC, and NECA’s "Standard of
Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed
under the Mechanical Division of these Specifications.

C. Division 22 has responsibilities for electrically powered or controlled plumbing equipment, which is
specified in Division 22 Specifications or scheduled on Division 22 Drawings. The specific division of
responsibilities between Division 22 and 26 for furnishing or wiring this equipment is as follows:

1. Division 22 Mechanical Responsibilities:
   a. MOTORS: Furnish and install all motors necessary for plumbing equipment.
   b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or
      automatically controlled which are necessary for mechanical equipment. Furnish
      these starters with all control relays or transformers necessary to interface with
      plumbing controls. If the starter is factory installed on a piece of Division 22
      equipment, also furnish and install the power wiring between starter and motor.
   c. DISCONNECTS: Provide the disconnects which are part of factory wired Division
      22 plumbing equipment. Factory wiring to include wiring between motor and
      disconnect or combination starter/disconnect.
   d. CONTROLS: Division 22 Contractor is responsible for the following equipment in
      its entirety. This equipment includes but is not limited to the following:
      1) Control relays necessary for controlling Division 22 equipment.
      2) Control transformers necessary for providing power to controls for Division
         22 equipment.
      3) Low or non-load voltage control components
      4) Non-life safety related valve
      5) Solenoid valves, EP and PE switches

D. Division 26 has responsibilities for electrically powered or controlled equipment which is specified in
Division 22 Specifications or scheduled on Division 22 Drawings. The specific division of
responsibilities between Division 22 and 26 for furnishing or wiring this equipment is as follows:

1. Division 26 Electrical Responsibilities:
   a. MOTORS: Provide the power wiring for the motors.
   b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on
      Division 22 factory assembled equipment, Division 26 is to install magnetic starters
      furnished by Division 22 and install the necessary power wiring to the starter and
      from the starter to the motor. In the case of factory installed starters, Division 26 is
      to install the necessary power wiring to the starter.
   c. DISCONNECTS: Provide all disconnects necessary for Division 22 mechanical
      equipment which are not provided as part of factory wired Division 22 equipment.
      Provide power wiring to all disconnects. In addition provide power wiring between
      motor and disconnect when the disconnect is not factory installed. See also
      Variable Frequency Drive above for special wiring requirements.
   d. CONTROLS: Division 26 Contractor is responsible for providing power to control
      panels and control circuit outlets.

2. Coordinate with other work, including wires/cables, raceway and equipment installation,
as necessary to properly interface installation of electrical connections for equipment with
other work.

3. Connect electrical power supply conductors to equipment conductors in accordance with
   equipment manufacturer’s written instructions and wiring diagrams. Mate and match
   conductors of electrical connections for proper interface between electrical power
   supplies and installed equipment.

4. Maintain existing electrical service and feeders to occupied areas and operational
   facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or
   Architect/Engineer. Provide temporary service during interruptions to existing facilities.
   When necessary, schedule momentary outages for replacing existing wiring systems with
   new wiring systems. When that “cutting-over” has been successfully accomplished,
   remove, relocate, or abandon existing wiring as indicated.
5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.6 PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of "Rust-O-Leum" Yellow. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.

B. All exposed work under Division 22 shall receive either a factory finish or a field prime coat finish, except:
   1. Exposed copper piping
   2. Aluminum jacketed outdoor insulated piping

3.7 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
   1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
   2. Locate pipe markers as follows:
      a. Near each valve and control device
      b. Near each branch, excluding short take-offs for fixtures mark each pipe at branch, where there could be question of flow pattern.
      c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures
      d. At access doors, manholes, and similar access points which permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination
      f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.

C. Plumbing Equipment Identification: Locate engraved plastic laminate signs on or near each major item of plumbing equipment and each operational device. Provide signs for the following:
   1. Main control and operating valves, including safety devices
   2. Meters, gauges, thermometers, and similar units
   3. Pumps and similar motor-driven units
   4. Hot water system mixing valves and similar equipment
   5. Strainers, filters, treatment systems and similar equipment

D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.
3.8 VIBRATION AND DYNAMIC BALANCING
   A. Vibration tolerances shall be as specified by the "International Research and Development Corporation", Worthington, Ohio, measured by the displacement, peak to peak, as follows:
      1. Pump and Electric Motors: Below severity chart labeled "SLIGHTLY ROUGH", maximum vibration velocity of 0.157 in/sec, peak.
      2. Compressors: Same as pumps.
   B. Correction shall be made to all equipment which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.9 TESTING
   A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220500: Basic Materials and Methods
B. Section 230700: Mechanical Insulation
C. Section 222113: Plumbing Piping, Valves and Specialties
D. Section 224000: Plumbing Fixtures
E. Section 221123: Plumbing Equipment
F. Section 222123: Pumps and specialties

1.3 SCOPE
A. All work includes removing and modifying existing and providing new plumbing. Systems as specified under this section shall include but not necessarily be limited to the following:
   1. Connection to existing building services and civil work.
   2. Removal of fixtures and piping as indicated on drawings. No pipe to be abandoned in place except piping below grade.
   3. Connection of all waste, vent, and water piping to all plumbing fixtures, drinking fountains, sinks, drains and mechanical equipment.
   4. Provide for future expansion as indicated.
   5. Connect to new mechanical equipment including chiller, cooling tower expansion tanks, domestic hot water heaters, and boilers, etc.
   6. Connect hot and/or cold water to hose bibbs and wall hydrants. Provide individual shut-off valves at each location.
   7. Provide traps on all floor drains with trap primer where specified. Pipe to trap shall be ½” minimum.
   8. Provide domestic hot water recirculation system. Each branch line to be set at one (1) gpm. Provide individual shut-off valve, check valve and ball valve with memory stop at each location.
   9. Provide floor drainage in core toilets, mechanical rooms and equipment rooms.
  10. Provide connections for all area drains, catch basins, downspouts, roof drains to storm sewer system.
  11. Gas service and meter assembly for HVAC equipment (and) domestic water heaters shall be by local gas purveyor.
  12. Temporary Water Service: As directed by the General Contractor, the plumber shall provide a temporary metered water service and temporary water risers with four (2) hose bibbs installed at each level as the building proceeds upwards to the roof.

1.4 SUBMITTALS
A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer’s data, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Plumbing specialties
   2. Trap primers
   3. Cleanouts
   4. Drains
   5. Roof flashing
   6. Wall hydrants and hose bibbs
PLUMBING

7. Mixing valves
   B. Contractor shall submit a letter that all products used in the plumbing installed are certified for use in the State of Oregon.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products to the site in containers with manufacturer’s stamp or label affixed.
   B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.

1.6 WARRANTY
   A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 GENERAL
   A. All materials and equipment under this Division of the Specifications shall be new, of best grade and as listed in printed catalogs of the manufacturer.
   B. All manufactured materials shall be delivered and stored in their original containers. Equipment shall be clearly marked or stamped with the manufacturer's name and rating.
   C. All items shall be furnished Vandal Proofed. One type of vandal proof screw is to be used throughout this facility. Coordinate with general contractor for type.
   D. The following products to be included as part of this work but specified under Section 220500 Basic Materials and Methods and Section 222113 Plumbing Piping, Valves and Specialties:
      1. Piping
      2. Valves
      3. Hangers and supports
      4. Escutcheon plates, flashings, and sleeves
      5. Identification markers and signs
      6. Anchors, alignment guides and Seismic Zone 3 requirements
      7. Excavation and backfill
      8. Pressure and temperature gauges
      9. Access Panels
   E. Plumbing Fixtures: Refer to Section 224000.

2.2 VALVES: DOMESTIC WATER AND NATURAL GAS (See Section 222113)

2.3 CLEANOUTS
   A. Cleanout Plugs: Bronze, taper thread countersunk head.
   B. Floor Cleanouts: Service weight cast-iron body and frame, flange with flashing clamp, adjustable cast-iron collar, caulk inside, Ty-seal or No-hub joints, neoprene plug gasket seal.
      1. Carpeted Areas: Zurn ZN-1400-KC-VP-BP-CM or J. R. Smith 4028 C - F - C - Y - U
      2. Tiled Areas: Zurn ZN-1400-X-KC-VP-BP or J. R. Smith 4148 - F - C - U
      3. Unfinished Areas: Zurn ZN-1400-HD-KC-VP-BP or J. R. Smith 4108 C - F - C - U
      4. Yard Areas: Zurn Z 1474-IN-VP or J. R. Smith 4258 - C - U
   C. Cleanout Tee: Cast iron cleanout tee with countersunk brass plug, neoprene plug gasket seal and smooth stainless steel cover.
      1. Manufacturer: Zurn Z-1446-BP or J. R. Smith 4532 S (Y)
2.4 ROOF FLASHING
A. Flashing: Unless indicated otherwise on the drawings flashings for pipes through the roof shall be galvanized sheet metal, 24 gauge minimum with seams and joints lapped and soldered watertight. Coordinate with Architectural Sections for flashings and roofing.
B. Vent Pipes: Provide caulk type, vandalproof hood with Allen head vandal proof screws for all vent pipes through roof or preformed vinyl/galvanized steel assembly.

2.5 WATER HAMMER ARRESTORS
A. Piston Type: Hard drawn copper construction, mirror finished internal surfaces; machine finished brass piston, air charged, 250 psi rated, tested and certified per PDI WH-201 and ASSE 1015. Coordinate location of access panels with Architect or provide access panel where none are shown.
   1. Manufacturer: Precision Plumbing series SC, or Sioux Chief.

2.6 ANTI-CONTAMINATION WALL HYDRANTS AND HOSE BIBBS
A. Anti-Contamination Wall Hydrant, WH-1: Exterior, box-type, freezeproof, cast-bronze construction, chrome plated finish, loose key, bronze casing, length to suit wall thickness, vacuum breaker/backflow preventor, 3/4" inlet, 3/4" threaded hose end, solder joint.
   1. Manufacturer: Smith 5509QT, Zurn or Watts
B. Anti-contamination Hose Bibbs, HB-1: Bronze body construction, polished chrome plated finish, renewable composition disc, wheel handle, 1/2" NPT inlet, 3/4" threaded hose end, vacuum breaker/backflow preventer, solder joint, ANSI 1011.
   1. Manufacturer: Woodford series 24P or Zurn Z1341.

2.7 DRAINS
A. General: Provide drains of type and size as indicated on drawings, including features, as specified herein.
B. Floor Drain, FD-1 - Finished Areas: Enamel coated cast iron body with flange, integral reversible clamping collar, seepage openings, adjustable round satin nickel bronze strainer, sediment bucket, bottom outlet, caulk inside or Ty-Seal or no-hub joint. Provide trap primer.
C. Floor Drain, FD-2 - Mechanical Rooms: Enamel coated cast iron body with flange, clamping collar, seepage openings, 8-1/2" diameter adjustable cast iron bar strainer, sediment bucket, bottom outlet, caulk inside or Ty-Seal or no-hub joint. Provide trap primer.
   1. Manufacturer: Zurn Z-520-Y-P or J.R. Smith 2350 C(Y).
D. Floor Sink, FS-1: Enamel coated cast iron body with seepage flange, acid resistant interior surfaces, aluminum dome strainer, 12" x 12" x 6", half grate, bottom outlet, caulk inside, Ty-Seal or no-hub joint. Provide trap primer.
   1. Manufacturer: Commercial Enameling series 906-1 or Zurn-ZFD-2375-K-H-Y.
E. Roof Drain, RD-1: 16" diameter, enamel coated cast iron body with flange, flashing ring with gravel stop, under deck clamp, extension, sump receiver, 10-7/8" aluminum mushroom domes, caulk inside, Ty-Seal or no-hub joint.
   1. Manufacturer: J.R. Smith 1010 - C(Y) - C - R - CL - AD – AD or Zurn ZA-100-C-R.
F. Overflow Roof Drain, OD-1: 16" diameter, Enamel coated cast iron body with flange, flashing ring with gravel stop, underdeck clamp, extension, sump receiver, standpipe collar, aluminum dome, caulk inside, Ty-Seal or no-hub joint.
   1. Manufacturer: J.R. Smith 1070-C(Y)-C-R-E-CL-AD or Zurn ZA-100-W2-DP.
G. Downspout Fitting, DSN-1: Fabricated stainless steel downspout cover with hinged perforated cover.
   1. Manufacturer: J.R. Smith 1775.
H. Downspout connector, DSC-1: Cast iron construction, plain end outlet.
   1. Manufacturer: Neenah Series, R4927 or Zurn Z-192.

2.8 TRAP PRIMER
A. Cast bronze construction, vacuum breaker, ½" sweat solder connection. Install in accessible location or provide access panel.
   1. Manufacturer: PPP Oregon #1 or E&S, for use for up to 8 drains using PPP trap primer distribution units.
   2. Option: Sloan F-72-A1 used in conjunction with water closet flush valve.
B. For Multiple Units or Kitchen Areas: PPP Prime Time electronic trap primer Series PT. Coordinate 120 V, electrical service with Division 26.

2.9 MIXING VALVES ASSEMBLY
A. Mixing Valve: 300 psi, Brass construction, thermostatic controller with check stops. Refer to drawings for schedule of each valve. Use high/low type for uses over 20 gpm.
B. Manufacturer: Holby, Lawler, Symmons or Leonard.

2.10 EMERGENCY SHOWERS AND EYEWASHES:
A. Emergency Eye Wash, EW-1:
   1. Deck mounted swing away style with dust covers.
   2. Manufacturer: Haws 7612.
   3. Mixing valve: Lawler 911 EF or Guardian.
B. Emergency Shower; ESH-1:
   1. Deluge shower 30 GPM flow control and pull handle.

2.11 BUILDING DOMESTIC WATER METERING, COLD; REQUIRED:
A. All measurements are to be remote monitored via the DDC system.
B. Usage/flow is to be measured in K-gallons, calculated at the remote readout, and then pulsed to the DDC system.
C. Flow meters:
   1. Pulse output ONLY via the DDC system.
   2. Approved manufacturers: Foxboro; Bailey; Cadillac.

PART 3 - EXECUTION
3.1 GENERAL
A. This system to be installed by an experienced firm regularly engaged in the installation of plumbing systems as specified by the requirements of the Specifications.
B. Install all items specified in this section of the Specification under the full purview of local and state governing agencies.
C. Refer to Section 220500: General Plumbing Requirements for installation of piping, valves and other requirements.

3.2 PERFORMANCE OF WORK
A. Examine areas, physical conditions and phasing requirements under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings.
PLUMBING

B. Work shall start immediately after authorization has been given to proceed so that the overall progress of the construction is not delayed. No foundry items to be installed until submittals have been approved.

C. Coordinate with other trades as necessary to properly interface components of the plumbing system.

D. Follow manufacturer's directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the drawings or covered in these Specifications.

E. The omission from the drawings or Specifications of any details of construction, installation, materials, or essential specialties shall not relieve the Contractor from furnishing the same in place for a complete system.

3.3 PIPING INSTALLATION

A. The word “piping” shall mean all pipes, fittings, nipples, valves and all accessories connected thereto.

B. Run piping generally parallel to the axis of the building, arranged to conform to the building requirements and to suit the necessities of clearance for other mechanical ducts, flues, conduits and work of other trades and close to ceiling or other construction as practical, free of unnecessary traps or bends.

C. Run horizontal sanitary drainage at uniform pitch of not less than 1/8” per foot, unless otherwise indicated. Pitch horizontal vent piping downward from stack to fixtures.

D. Run drainage piping as straight as possible with long radius turns. Offsets shall be made at an angle of 45° or less.

E. Grade water supply piping for complete drainage of the system. Install hose bibbs at low points.

F. Piping connections to all equipment shall be made up with unions.

G. Provide sufficient elbows, swings and offsets to permit free expansion and contraction.

H. Use reducers or increasers. Use no bushings.

I. Ream or file each pipe to remove burrs. Inspect each length of pipe and each fitting for workmanship and clear passageway.

J. Vent pipes to terminate at least 6” above the roof. Provide vandal proof hood assembly.

K. Cover, cap or otherwise protect open ends of all piping during construction to prevent damage to threads or flanges and prevent entry of foreign matter. Disinfect water supply piping as specified.

L. Exposed connections to equipment shall be installed with special care, showing no tool marks or threads at fittings and piping. No bowed or bend piping to be permitted.

M. All ferrous to non-ferrous connections shall be made by means of dielectric fittings. Submit shop drawings for approval.

N. Use extra heavy pipe for nipples, where unthreaded portion is less than 1½”. Use no close nipples. Use only shoulder nipples.

O. All piping shall be inspected for defects and flaws prior to installation. Remove any damaged piping from job site. Piping shall be thoroughly cleaned of dirt, debris or rust.

P. Cleanouts to be provided at each change in direction greater than 135° or 100’ maximum intervals on underground piping.

Q. Revise existing cleanout elevations to be flush with new floor elevation.

R. Cleanouts to be same size as pipe except cleanout plugs larger than 4” shall not be required.
S. Cleanouts on concealed piping to be extended through and terminate flush with the finished wall or floor. Cover plates to be provided on all cleanout plugs in finished areas.

T. The bodies of cleanout ferrules to conform in thickness to that required for pipe and fittings of the same metal.

U. Route piping on roof on manufactured polyethylene pipe pier supports “Pipe Pier” by Erico.

3.4 WATER HAMMER ARRESTERs

A. Install as per PDI Standard WH-20 and equipment manufacturer’s recommendation and as shown on working drawings. Provide before each quick closing valve (flush valve, solenoid valve, etc.) or bank of fixtures.

B. Install at each plumbing fixture, bank of fixtures, equipment and as indicated.

3.5 TESTING AND DISINFECTING - PLUMBING SYSTEMS

A. General: The Contractor to perform all field tests and provide all labor, equipment, and incidentals required for the tests. Owner to witness all field tests and conduct all field inspections. The Contractor to give the Owner ample notice of the dates and times scheduled for tests. Any deficiencies to be completely retested at no additional cost.

1. Inspection: Inspection to continue during installation and testing. Perform a final inspection of the equipment prior to installation to determine conformity to the type, class, grade, size, capacity, and other characteristics specified herein or indicated. Correct or replace all rejected equipment prior to installation.

2. Water Distribution Piping Test: Before fixtures are set, subject the entire hot and cold piping system to a hydrostatic pressure test of 150 pounds per square inch with water for not less than 8 hours in order to permit inspection of all joints with no evidence of leakage. Where a portion of the water distribution piping is to be concealed before completion, test this portion separately as specified for the entire system.

3. Sanitary, Waste, Storm, Rainwater, and Vent Piping Test: Before the installation of any fixtures or drains, cap the ends of the system and fill all lines with water to the roof level and allow to stand for at least 30 minutes without leakage. Make tests within building with piping exposed. If the system is tested in sections, tightly lug each opening, except the highest opening of the section under test, and fill each section with water and test with at least a 10’ head of water.

4. Sanitary Drainage Vent, Storm, Rainwater and Fixture System Final Test: Give sanitary, drainage vent, and fixture systems an in-service test after complete installation. After all fixtures are installed, test the entire vent and sewer system and prove gas and water tight. Final test shall be with air. Before proceeding with test, fill all traps with water. Close all stacks and line openings during test, for a minimum period of 24 hours. If test reveals leakage of air at any point, repair and retest the system.

5. Disinfection of Water Distribution System: After pressure tests have been made thoroughly flush the entire domestic water distribution system with water until all entrained dirt and mud have been removed, and sterilize by chlorinating material. The chlorinating material shall be liquid chlorine. The chlorinating material shall provide a dosage of not less than 50 parts per million and shall be introduced into the system or part thereof in an approved manner. Retain the treated water in the pipe for 24 hours, or, fill the system or part thereof with a water-chlorine solution containing at least 200 parts per million of chlorine and allow to stand for three hours. Open and close all valves in the system being disinfected three times during the contact period. Then flush the system with clean potable water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period open and close all valves and faucets three times. From at least three divergent points in the system, take samples of water in properly sterilized containers for bacterial examination. Repeat the disinfecting until tests indicate that satisfactory bacteriological results have been obtained.

a. Taking of samples shall be witnessed by Architect or Owner’s representative. Samples are to be taken and tested by an independent analytical testing laboratory.
PLUMBING

Written reports shall be supplied to Architect for approval.

3.6 OPERATING TESTING AND CERTIFICATION - PLUMBING SYSTEMS

A. Upon completion and disinfection, and prior to acceptance of the installation, the Contractor to subject the plumbing system to operating tests to demonstrate satisfactory, functional, and operating efficiency. Such operating tests to include the following information in a report with conclusions as to the adequacy of the system.
   1. Time, date, and duration of tests
   2. Water pressures at most remote location
   3. Operation of all valves and hydrants
   4. Operation of all floor drains by flooding with water
   5. Quality of domestic water
   6. Read all indicating instruments at half-hour intervals unless otherwise directed. Supply four copies of the test report to the Owner

3.7 CLEANING EQUIPMENT AND MATERIALS

A. In addition to the requirements of Section 220500, provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care to be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors, and similar equipment.

B. All piping, finished surfaces, and equipment to have all grease, adhesive labels, and foreign materials removed.

C. All piping to be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, flush valves, and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation for ten days.

D. When connections are to be made to existing systems, the Contractor is to do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.

3.8 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES

A. General: Refer to Section 220500 for details.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:
   1. Piping:
      a. Domestic hot water supply and return
      b. Domestic cold water
      c. Horizontal roof and overflow drain piping
      d. Underground water piping
      e. Sanitary vent piping in unheated spaces
      f. Drains from electric water coolers to first connection
      g. Horizontal pipe runs from fixtures receiving cold condensate
      h. All valves, separators, strainers and fittings for systems listed above
   2. Drains:
      a. All roof and overflow drain bodies
B. Types of mechanical insulation specified in this Section include the following:
   1. Fiberglass pipe insulation
   2. Cellular glass pipe insulation
   3. Calcium silicate pipe insulation
   4. Flexible elastomeric closed cell insulation
   5. Fiberglass equipment insulation
   6. Calcium silicate equipment insulation
   7. Cellular glass equipment insulation
   8. Flexible unicellular equipment insulation
   9. Insulation jackets
   10. Insulation accessories

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing

1.4 DEFINITIONS
A. Ambient: The air temperature to be maintained in a conditioned room. Typically between 70°F and 78°F.
B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
PLUMBING INSULATION

G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.

H. Freezing Climate: Where outdoor design temperature is less than 33°F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:

1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
   a. B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
   b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation
   c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations
   d. C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission
   e. Properties by Means of the Guarded-Hot-Plate Apparatus
   g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement
   h. C302 - Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation
   i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation
   j. C305 - Test for Thermal Conductivity of Pipe Insulation
   k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation
   l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation
   m. C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
   p. C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation
   q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
   r. C547 - Specification for Mineral Fiber Preformed Pipe Insulation
   s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation
   t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type)
   u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered)
   v. C612 - Specification for Mineral Fiber Block and Board Thermal Insulation
   w. C916 - Standard Specification for Adhesives for Duct Thermal Insulation
   x. C921 - Practice for Determining Properties of Jacketing Materials for Thermal Insulation
   bb. E84 - Test Method for Surface Burning Characteristics of Building Materials
   cc. E119 - Test for Fire Resistance
   dd. G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
PLUMBING INSULATION

1. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
   a. 90 Energy Conservation in New Building Design

2. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:
   a. 255 Test Methods, Surface Burning Characteristics of Building Materials

B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

C. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

D. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.
   1. Test Specimen: Two specimens shall be used, each measuring 1” by 4” by approximately ½” thick.
   2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1” wide, 4” long and 0.020” thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lb/sq. ft.
   3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.

E. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory. Submit samples.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
PLUMBING INSULATION

A. Johns Manville, Owens-Corning, Knauf, Armstrong, Pittsburgh-Corning, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix, or approved equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.2 PIPE INSULATIONS

A. Glass Fiber: Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.

1. Manufacturers:
   a. Johns Manville Micro-Lok Meeting ASTM C547; or Micro-Flex (pipe sizes larger than 18”), Knauf insulation.

2. Applications: Insulation of piping up to 18” in diameter and 3” thick insulation.

3. ’K’ Value: 0.23 at 75°F

4. Maximum Service Temperature: 850°F

5. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.

B. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C522: Cellular Glass Thermal Insulation:

1. ’K’ Value: 0.35 at 75°F

2. Density: 8.0 lbs./cu. ft.

3. Maximum Service Temperature: 900°F


1. ’K’ Value: 0.27 at 75°F

2. Density: 3.0 to 6.0 lbs./cu.ft.

3. Maximum Service Temperature: 260°F

4. Seal all seams and joints with contact adhesive.

D. Field Applied Jackets (For Interior Applications):

1. All longitudinal seams shall be located on bottom of pipes.


4. Aluminum Jacket: 0.016” thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner.

5. Secure aluminum jackets with 3/8” or ½” stainless steel bands on 12” centers.

E. Removable Covers:

1. Provide removable covers on pumps, valves, air separators, vents, fittings, flanges, strainers, traps, etc., where periodic maintenance or removal of insulation may be required.

2. Use of premolded fittings with PVC covers is acceptable.

3. Use of lace-on type insulating blankets is acceptable.

2.3 EQUIPMENT INSULATIONS

A. Flexible Fiberglass Blanket: Johns Manville Microlite Type 75 Flexible Blanket:

1. ’K’ Value: ASTM C518, 0.27 Btu•in./(hr•ft²•ºF) at 75°F installed full thickness.

2. Maximum Service Temperature: 250°F.

3. Density: 0.75 lb/cu ft.

4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure...
PLUMBING INSULATION

sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation:
   1. 'K' Value: 0.35 at 75°F.
   2. Density: 8.0 lb/cu. ft.
   3. Maximum Service Temperature: 900°F.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. General:
   1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
   2. Remove and replace any insulation that has become wet or damaged during the construction process.
   3. Continue insulation and vapor barrier at penetrations and supports, except where prohibited by code.

B. Piping Insulation:
   1. Locate insulation and cover seams in least visible locations unless otherwise specified.
   2. Neatly finish insulation at supports, protrusions, and interruptions.
   3. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system.
   4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Bevel and seal ends of insulation at equipment, flanges, and unions.
   5. Provide minimum 1 inch air space between insulation and casing.
   6. Provide insert between support shield and piping on piping 1½” diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
      a. 1½" to 2½" pipe size 10" long
      b. 3" to 6" pipe size 12" long
      c. 8" to 10" pipe size 16" long
      d. 12" and over 22" long
   7. Use of metal saddles is acceptable as specified in Section 15050. Fill interior voids with segments of insulation matching adjoining pipe insulation.
   8. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.
   9. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers, or aluminum or stainless steel jacket.
   10. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of premolded covers or lace-on type insulation blankets is required.
   11. For exterior applications:
PLUMBING INSULATION

a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).

b. Apply weather-resistant protective finish such as WB Armalux to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armalux 520 BLV adhesive.

12. For underground installations, install per manufacturer’s written instructions and recommendations.

13. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

C. Equipment Insulation:

1. See Piping Insulation above for additional requirements.

2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer’s recommendations.

3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.

4. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.

5. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.

6. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket as indicated in the drawings.

7. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.

8. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

9. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of lace-on type insulation blankets is acceptable.

3.3 PIPING INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness ½” if exposed to exterior ambient air. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior “K” factors.

B. Fiberglass Insulation

<table>
<thead>
<tr>
<th>PIPE SIZE (inches)</th>
<th>THICKNESS (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic hot water</td>
<td>Up to 2 1/2 and over</td>
</tr>
<tr>
<td></td>
<td>All Sizes</td>
</tr>
<tr>
<td>Domestic hot water return</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Domestic cold water</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Roof and overflow drain bodies</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Horizontal &amp; vertical roof and overflow drainage</td>
<td>Up to 2 and over</td>
</tr>
<tr>
<td>Piping exposed to freezing</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Plumbing vents within 10 feet of the exterior in freezing</td>
<td>All Sizes</td>
</tr>
<tr>
<td>Climates</td>
<td>Pipe Size (inches)</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Misc. drains from electric water coolers, ice machines, etc.</td>
<td>All Sizes</td>
</tr>
</tbody>
</table>

C. Elastometric Foam (Closed Cell):

<table>
<thead>
<tr>
<th>Condensate drain pipes</th>
<th>Pipe Size (inches)</th>
<th>Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sizes</td>
<td></td>
<td>1/2</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this section shall include but not necessarily be limited to the following:
1. Water heaters
2. Storage Tank
3. Expansion Tank
4. Water feature equipment
5. Oil Interceptor
6. Solids Interceptor
7. Dilution Tank
8. Grease Interceptor
9. Lint Trap
10. Water meters
11. Drop inlets
12. Curb inlets

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing
C. Section 224000: Plumbing Fixtures
D. Section 222123: Plumbing Pumps

1.4 SUBMITTALS
A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
1. Water heaters
2. Storage Tank
3. Expansion Tank
4. Water feature equipment
5. Oil Interceptor
6. Solids Interceptor
7. Dilution Tank
8. Grease Interceptor
9. Lint Trap
10. Water meters
11. Drop inlets
12. Curb inlets

B. Electrical Work: Refer to Division 22, Section 220500 for requirements.

C. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages.
PLUMBING EQUIPMENT

D. Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

E. Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory, including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 01.

F. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.

G. Start-up: Provide written report on start-up in accordance with Section 220500.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.

1.6 WARRANTY

A. Provide one year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses to repair or replace products or systems.

PART 2 - PRODUCTS

2.1 DOMESTIC HOT WATER STORAGE TANK,

2.2 WATER HEATER - STEAM

A. Furnish and install where indicated on the drawings, the Adamson Co., Inc. Dura Pak factory packaged, steam heated, storage heater.

B. The storage tank shall be constructed and stamped in accordance with Section VIII, Division 1, of the current edition of the ASME Code for Pressure Vessels. Three (3) copies of the manufacturer's data reports signed by a registered inspector shall be furnished.

C. All openings 3" and smaller shall be threaded couplings.

D. The recovery section shall be constructed with non-ferrous tube sheet, wrapper and baffles. All heat transfer surfaces shall be 3/4" OD, 18 gauge seamless copper tubing. A demand monitor shall be provided to proportion steam flow to the heating element during periods of small or large draws of water. Temperature shall be maintained to plus or minus 5 degrees of the desired outlet temperature. All integral piping on the water circulation system shall be copper.

E. Each vessel shall be delivered completely assembled prior to shipment to the job site, and will include the following:

1. One vertical storage tank.
2. _____ inch diameter by _____ inch high. Storage capacity of _____ gallons.
3. Tank Lining: Baked-on phenolic.
5. Heating Capacity: _____ GPH, 40° F to _____° F.
6. Steam Pressure: _____ # in the main.
7. Steam control valve air operated.

F. Steam strainer:

1. Main steam trap, condensate strainer, and component black steel piping.
2. Auxiliary steam trap and piping.
3. Bronze integral circulating pump, hand valves and copper piping.
4. Copper distributor pipe.
PLUMBING EQUIPMENT

5. Console with thermometer, steam pressure gage and water pressure gage.
6. Relief valve.
7. Factory insulation, 1-1/2" fiberglass, steel jacket and painted.
8. Permanent skid type supports.
9. On-off switch, thermal overload protection and wiring for the integral pump.

G. Contractor shall supply all valves, gauges and drain lines as indicated. Relief and regulation valves shall have not less than 100% of the gross output of the equipment.

H. Acceptable Manufacturer: Adamson, RECO, Sellers or Patterson Kelly.

2.3 HOT WATER HEATER - ELECTRIC

A. The heater shall be a glass-lined dura-power supreme commercial electric Model DSE as manufactured by A.O. Smith Corporation.

B. Heater should be rated at capacities indicated on contract documents and constructed in accordance with ASME code shall bear appropriate symbol and listed with the National Board as required. Heater shall be listed with Underwriters' Laboratories and approved by National Sanitation Foundation.

C. All internal surfaces of the tank shall be glass-lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature of 1600° F. Tank shall be cathodically protected with adequate extruded magnesium anode. The entire vessel is to be enclosed in a round steel enclosure with baked enamel finish.

D. Control compartment to be hinged and shall house 120 volt control circuit transformer, transformer fusing, magnetic contactor(s), immersion style operating thermostat(s), element fusing per NEC, and commercial grade incoloy sheathed flange mounted elements with pre-wired thermal leads. Temperature controls include limiting switch which will require resetting manually in the event the temperature reaches 190° F.

E. Foam insulation (R-16) shall exceed latest requirements of ASHRAE (currently 90A-1980) for heat loss efficiency.

F. Heater shall include ASME T & P relief valve and drain valve.

G. Warranty: 3 years, professional start-up to be included.

H. Acceptable Equals: A. O. Smith, Bradford-White, Lochinvar, or RECO.

2.4 RELIEF VALVES

A. Relief Valve: Watts vacuum relief valve, bronze body, silicone disc, threaded ends, installed on C.W. supply line only, refer to H.W. Heater Detail on contract drawings.

B. Temperature and Pressure Relief Valve: Watts, bronze body construction, thermostat and test lever, temperature relief set at 210°F, and pressure relief set at 125 psi.

C. Acceptable manufacturers: Watts, Kunkle, Keckley or Cash Acme.

2.5 EXPANSION TANK

A. Furnish and install where shown on plans for domestic hot water system.

B. ASME stamped and constructed vessel with the following:
   1. Tanks rated for 125 / 150 psi maximum working pressure.
   2. Black steel galvanized construction painted with "Hammertone" blue enamel.
   3. Tank saddle supports / Tank ring base support.
   5. Butyl diaphragm bonded to polypropylene liner.
   6. Pre-charged air chamber permanently sealed.
   7. Air valve.

C. Manufacturer: Amtrol AST, Adamson, RECO or Watts.
PLUMBING EQUIPMENT

2.6 WATER METERS
A. Water meter shall have a mechanical drive with hermetically sealed registers; meter shall be equal to or exceed AWWA Standards and shall have an all bronze case. Provide water meters installed complete with gate valve on each side of meter and full line size bypass around meter. Provide flanges on valves and support stands or wall brackets for meter support. Units shall be approved for use by local water district. Hersey Products Inc #MHD, Niagra or Rockwell. Meter shall be rated ______ gpm at ______ psi inlet pressure.

B. Drop inlets exceeding four feet in depth may be poured in two or more units, and shall be provided with inter-locking keyed joints which shall be grouted with 1:4 mortar during installation. Two inch diameter lifting holes shall be provided to facilitate job handling. Grates and frames shall be constructed of structural steel. Steel grates and frames shall be hot dipped galvanized after fabrication to requirements of ASTM specifications A123. All frames shall be integrally cast. The top surface of the drop inlet shall be finished smooth, shall be square and clean. Wall surfaces shall be formed, shall be flat and true to dimension.

2.7 GREASE TRAP, GT-1
A. Grease traps to be constructed of duco coated steel. Provide with removal baffles and flow control.
B. Provide with extensions for flush with floor installation and vent.
C. Manufacturer: JR. Smith 8050, Zurn or Wade.

2.8 GREASE INTERCEPTER, GT-1
A. Grease interceptor to be constructed of concrete with two / three 24” clear access manholes with traffic weight frame and covers.
B. Interceptor to be IAPMO listed and have a minimum of 2 components. See schedule for capacity.
C. Provide solids interceptor up stream of interceptor Utility Vault 576.
E. Manufacturer: Utility Vault.

2.9 LINT TRAP, LT-1:
A. Lint Separator shall be Rockford Lint Separator as manufactured by the Rockford Sanitary Systems, Rockford, Illinois, and as noted on plans.
B. Separator: Furnish and install Rockford Model RLS-135 all-welded steel separator with extension up to finished floor, 6", hubbed, inlet and outlet with vent connection, internal vent connection, visible double wall outside trap seal, anchor flange without clamping ring, epoxy coating, anodes, sediment basket, reinforced cover for light traffic, secured with stainless steel bolts, heavy duty leakproof gasket, enamel coating inside, and bituminous coating outside.
C. Unit shall be installed in reinforced concrete vault as indicated on plans. Refer to Detail Sheet P6.3.

2.10 OIL INTERCEPTOR, OIT-1
A. Construction: Cast iron interceptor with acid resisting rubber base coating inside and out, double wall trap with cleanout, 2" vent connection, removable baffle, flow control fitting, gasketed cover, 3" inlet and 3" outlet. Provide with extension for flush mounting.
B. Manufacturer: J.R. Smith 8550 or Zurn.

2.11 SOLIDS INTERCEPTOR, SIT-1:
A. Interceptor: Rockford GFE, 30 gpm, 3" outlet, 21" x 21" x 27" deep, 10 gauge steel with non-skid bolted top; coat interceptor exterior twice with Bitumastic.

2.12 DILUTION TANK, DT-1:
PLUMBING EQUIPMENT

A. Tank: 17” diameter x 31 ½” high, high density polyethylene neutralization tank.

B. Extension: 17” diameter high density polyethylene extension.

C. Top Door: Circular loose lid Bolton and Flangon 1” above finished floor.

D. Provide 4” concrete pad under dilution tank.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

C. Orient so controls and devices needing service and maintenance have adequate access.

D. Connect water piping to units with shutoff valves and unions as indicated.

E. Start-Up: Start-up, test, and adjust equipment in accordance with manufacturer's start-up instructions. Check and calibrate controls. Start-up to be by authorized manufacturer's representative or agent.

3.2 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES

A. General: Refer to Section 220500 for details.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to the following:
   1. Pipe and Fittings
      a. Sanitary waste and vent
      b. Storm drain and overflow
      c. Cold water
      d. Hot water
      e. Fuel gas
   2. Valves
      a. Water valves
      b. Backwater valves
      c. Natural gas valves
      d. Balancing valves
      e. Backflow prevention valves
      f. Pressure reducing valves
      g. Gas pressure regulator valves
      h. Thermostatic mixing valves
      i. Solenoid valves
   3. Thermometers and gauges
   4. Piping specialties
      a. Pipe escutcheons
      b. Strainers
      c. Drip pans
      d. Air vent
      e. Brass unions and flanges
      f. Unions
      g. Flanges
      h. Pipe sleeves
      i. Sleeve seals
      j. Valve boxes
      k. Pipe coating
      l. Gas connectors

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing
C. Section 224000: Plumbing Fixtures
D. Section 221123: Plumbing Equipment
E. Division 26: Electrical
1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

B. Codes and Standards:
   1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
   2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
   3. Perform all tests required by governing authorities and as required under all Division 22 Sections. Provide written reports on all tests.
   4. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and so identified.
   5. All plumbing work shall comply with the Americans with Disabilities Act (ADA).
   6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for all piping, valves and specialties indicating dimensions, valve CV, tolerances etc.

B. Shop Drawings: Submit shop drawings indicating underground piping installation showing all fittings with inverts. Indicate all footings and grade beams.

C. Maintenance Data: Submit maintenance instructions on accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
   1. All pipe, pipe fittings and valves shall be manufactured in North America. Alternatives may be acceptable, but must be submitted and approved by the Engineer prior to bidding.
   OR
   2. Upon request, the engineer shall be furnished certification by the manufacturer, stating samples representing each lot have been tested and inspected as indicated in governing ASTM specifications have been met. Certification shall be accompanied by test reports as prepared in accordance with relevant ASTM sections governing Test Methods and Inspection. Tension Tests reports shall include breaking load, machined diameter of the test bars, and calculated tensile strength. Certification shall include the legal name and address of the manufacturer.

B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.

C. For all Grade B piping specified below grade provide a mill report with production identification numbers for piping submitted to permit tracking of pipe by mill and production lot.

D. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturer's names used herein, unless specifically noted that substitutes are not allowed.
2.2 STANDARD PIPE AND FITTING

A. Natural Gas Pipe & Fitting (Above Grade)
      a. Fittings: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged;
         ANSI B16.9, steel.
      b. Joints: 2" and smaller, threaded (except in the case of piping located in shafts or
         plenums which must be welded); all piping inside the building 2-1/2" and larger,
         ANSI B16.25 bevelweld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

B. Compressed Air Piping:
   1. Type "L" hard drawn copper tubing per ASTM-B-88.
      a. Fittings: Provide wrought copper fittings conforming to ANSI-A40.2. Clean, free
         from oxide and corrosion.
      b. Braze Alloy: SilPhos 15 or HP-101 B CU2 braze alloy with residual matter less
         than 0.015% (no flux shall be used).
      c. Valves
         1) Ball Valves: Socket end for braising, 2" and smaller; ANSI B16.34, 400 psi
            ASTM B16 brass 3-piece body, reinforced Teflon seats and seals,
            conventional part, blow out proof brass stem, stainless steel ball and
            extended solder cups.

C. Trap Primer Piping:
   1. Pipe: Domestic Only, ASTM  B88, Type K, soft drawn copper water tube.
   2. Fittings: No joints below ground. For pipes below grade double wrap with Scotch Wrap
      #51 or PASCO Wrap, with 50% overlap.

D. Domestic Water Pipe & Fittings (Below Grade):
   1. Pipe: ASTM B88, Type K hard drawn copper water tube.
   2. Fittings: Domestic Only, Elkhart, ANSI B16.22, wrought copper, 95%-5% tin-antimony
      solder joints. Wrap underground piping with Scotch Wrap or Pasco Wrap.

E. Condensate and indirect drains:
   1. Pipe: ASTM B88, Type M, hard drawn copper water tube.
   3. Joints: Lead-free solder joints. Solder shall be lead-free nickel/silver bearing solder
      meeting ASTM B-32, ASTM B-828. Flux shall be water soluble and shall meet CDA
      standard test method 1.0 and ASTM B813-91.
   4. Insulate condensate drain pipes with minimum ½" insulation to prevent moisture dripping
      from pipe.

F. Domestic Water Pipe & Fittings (Below Grade):
   1. Pipe: ASTM B88, Type K hard drawn copper water tube.
   2. Fittings: Domestic Only, Elkhart, ANSI B16.22, wrought copper, 95%-5% tin-antimony
      solder joints. Wrap underground piping with Scotch Wrap or Pasco Wrap.

G. Domestic Hot and Cold Water Pipe & Fittings (Above Grade):
   1. Pipe: ASTM B88, Type L, hard drawn copper water tube.
   2. Fittings: ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints.

H. Sanitary Sewer, Vent, Rainwater Pipe & Fittings:
   1. Pipe: Tyler or AB&I or Charlotte Pipe and Foundry, ASTM A-74, ASTM A-888 cast iron,
      bituminous coated, "No-Hub". Pipe and fittings shall be marked with the collective
      trademark of the Cast Iron Soil Pipe Institute and manufactured by AB &I, Charlotte or
      Tyler. Pipe showing rust or cracks in coating shall be removed and replaced.
   2. Fittings: No-hub, ASTM A-888.
   3. Couplings Below Grade: Heavy Duty Type 304 stainless steel couplings conforming to
      FM 1680 with neoprene sealing sleeve conforming to ASTM C-1540 having minimum
      shield thickness of 28 gauge. Husky SD-4000 or Clamp All 125 only.
PLUMBING PIPING, VALVES AND SPECIALTIES

4. Couplings Above Grade: Type 304 stainless steel couplings conforming to ASTM C-1540 and neoprene sealing sleeve, having minimum shield thickness of 34 gauge. Anaco or Ideal.

I. Rainwater Leader Pipe and Fittings (Exposed, Above Grade):
   1. Pipe: ASTM B306, DWV class, copper tube.
   3. Joints: Lead free solder. Lead solder shall not be present at the job site.

2.3 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted. No 125 lb valves.

B. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer’s figure number, size, location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer’s assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Acceptable manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
   1. Gate, Ball, Check or Butterfly: Apollo, Hammond, Milwaukee.
   2. Lubricated Plug Valves: Homestead, Resun, or Rockwell.
   3. Backflow Preventors: Conbraco or Febco.
   4. Pressure Reducing Valves: Apollo, Cash-Acme, Cla-Val or Wilkins.
   5. Solenoid Valves: ASCO, Automatic or Magnatrol.
   6. Circuit Setters: Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, or Tour & Anderson.

E. Valve Identification: Provide valves with manufacturer’s name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, other than plug valves. Provide one wrench for every 10 plug valves, and one in each size. Provide extended levers/stems for valves on insulated lines. For manual valves 2 ½" and larger located 8 feet above the floor in mechanical rooms provide chain operator to permit operating the valve from 4'-0" above floor.

G. Valve Features:
   1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
   2. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
   6. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2.4 DOMESTIC WATER SERVICE VALVES

A. Gate Valves:
   1. 2" and Smaller: Class 125, MSS SP-80, ASTM B62 cast bronze body, soldered ends, bronze bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum hand-wheel.
PLUMBING PIPING, VALVES AND SPECIALTIES

2. 2-1/2" and Larger: Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel.

B. Ball Valves:
1. 2 1/2" and Smaller: 600 psi, 2 piece, bronze body, threaded ends with union, chrome plated brass ball, Teflon seat, brass stem, steel handle, full port. Apollo 70 series.

C. Check Valves:
1. 2" and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, soldered ends for copper pipe, screwed cap, swing type, Teflon bronze disc.
2. 2-1/2" and Larger: Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings.
3. Vertical or High Flow: Class 125, cast bronze, high-flow body, TFE seat, brass check, stainless steel guide and spring. Watt #6015.

2.5 NATURAL GAS VALVES

A. Gate Valves:
1. ½" and ¾": Brass body, U.L. listed, CSA approved for pressure of system, bronze gate valve, 175 WOG. Apollo.
2. 1" thru 3": 175 psi working pressure, CSA and U.L. approved, bronze body, welded ends.

2.6 BALANCING VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Pressure Dependent Water Flow:
1. ½" and Larger: Construction and attachment style as required by piping system. Ball or globe valve design with memory stop. Valves shall be field adjustable. Install in pipe with minimum length of unrestricted straight pipe equivalent to five pipe diameters upstream and two pipe diameters downstream. Presso Venturi B-Plus series, Armstrong, or Tour & Anderson.

2.7 BACKFLOW PREVENTION VALVES

A. General: All backflow prevention valves shall be State approved and listed.

B. Reduced Pressure Zone Backflow Preventer for High Hazard Applications:
1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.
2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor.

C. Atmospheric Vacuum Breaker: Assembly shall consist of a bronze vacuum breaker body with silicone disc, and full size orifice. Device shall be IAPMO listed, meet ASSE std. 1001, and ANSI std. A113.1.1 Chrome plated in finish areas.

D. Pressure Vacuum Breaker: Assembly shall consist of a one piece bronze or stainless steel body, with stainless steel spring loaded check, rubber diaphragm, and atmospheric vent, breakaway set screw. Provide chrome plated in finish areas.

2.8 PRESSURE RELIEF VALVES

A. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required.
B. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required.

2.9 GAS PRESSURE REGULATOR VALVES
A. Diaphragm operated, steel construction of size and capacity as indicated on drawings. Regulators shall be approved serving gas supplier, CSA and UL listed. Fisher, Sherwood, or approved equal.

2.10 THERMOSTATIC MIXING VALVES
A. General: Thermostatic valve constructed of brass and stainless steel, with screwdriver locking temp. regulator and adjustable check stops. Provide access door with cylinder lock. Finish as selected by Architect. Powers E480 or Leonard #210 SB.
B. Master: High-low master thermostatic assembly of size and capacity as indicated on drawings. Bimetal motor, adjustable checkstops, inlet and outlet pressure gauges, thermometer with full port outlet ball valves shutoffs, locking temperature regulator and surface mount stainless steel cabinet as specified. Powers 1432-RC-E-Q or Leonard type TM186-PRV-RF-LTR-STSTL.

2.11 SOLENOID VALVES
A. UL listed, globe pattern bronze valve with threaded ends, stainless steel pilot, bronze piston, malleable iron solenoid assembly with ½" tapped conduit connections and Class "A" coil, 120 Volt, 60 Hertz. Solenoid valve shall be wired to the Fire Alarm System. The valve shall close instantly on application of current and open when de-energized. Provide solenoid valve on gas line into boiler and water heating rooms where the aggregate gas input is over 400,000 Btuh. Wire to "mushroom" button(s) outside of each door to room.

2.12 FIRE PROTECTION VALVES:
A. Refer to Section 211000.

2.13 THERMOMETERS AND GAUGES
A. General:
   1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
   2. No mercury shall be used in thermometers due to hazardous material classification.
B. Pressure Gauge cocks:
   1. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Gauge cock constructed of brass with ½" female NPT on each end, and "T" handle brass plug.
   2. Syphon: ¼" straight coil constructed of brass tubing with ¼" male NPT on each end.
   3. Snubber: ¼" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
C. Pressure Gauge Connector Test plugs:
   1. Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Constructed of brass and finish in nickel-plate, equip with ½" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap an chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.14 PIPING SPECIALTIES
A. General:
   1. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and
B. Pipe Escutcheons:
   1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
   2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
   3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

C. Low Pressure Y-Type Pipeline Strainers:
   1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64" perforations at 233 0.045" perforations per square inch.
   2. Threaded ends, 2" and smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with ball valve with brass cap. Sarco, Wheatley or Mueller.
   3. Flanged ends, 2-1/2" and larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with ball valve with brass cap. Sarco, Wheatley or Mueller.

D. Drip Pans:
   1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1" copper drain line connection. Extend 1" drain to nearest approved receptor.

E. Air Vent with Valves:
   1. Install in all closed and open loop water systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each automatic vent valve to facilitate servicing. A 3/8" type "L" copper tubing drain line shall be run to drain receptor to carry away water that valve discharges. Manual type vent may be used in lieu of automatic type, where specifically shown on the Drawings. Hoffman #79 or Dole.

F. Brass Unions:
   1. Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

G. Brass Flanges: Provide brass flanges for flanged transitions between dissimilar metal piping.

H. Unions:
   1. Unions shall be of type specified in following schedule:
      a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
      b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
      c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
      d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
      e. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.
PLUMBING PIPING, VALVES AND SPECIALTIES

I. Flanges:
1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.
3. Type of pipe and corresponding flanges as follows:
   a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
   b. Welded Steel Pipe, 150 lb. black forges steel welding flanges, 1/16” raised face ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.

J. Pipe Sleeves:
1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
2. Sleeves shall provide a minimum ½” annular clearance around pipe.
3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3” and smaller, 20 gauge; 4” to 6”, 16 gauge; over 6”, 14 gauge.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves by Adjust-to-Crete, AMI or Shamrock. Floor sleeves to extend a minimum of 1” above finished floor.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.

K. Sleeve Seals:
1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.
3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.

2.15 PIPE COATING
A. All underground steel and copper pipe fittings, and all above ground steel and copper pipe and fittings in corrosive air environments shall be covered with one of the following methods:
1. Twice Wrap 20 Mil. Scotch Wrap PVC No. 51, 50% overlap.
2. Prefabricated extruded plastic cover with joints sealed with two coats of 20 Mil. Scotch Wrap No. 51 or Pasco Wrap 20 mil weight.
B. Furnish corrugated stainless steel tubing (CSST) with factory-applied corrosion-resistant polyethylene jacket for use in corrosive atmosphere. Coating properties include the following:
1. Gastite corrugated stainless steel tube jacket shall be UV-Resistant polyethylene meeting the requirements of ASTM E84 for flame spread and smoke density.

2.16 GAS CONNECTORS
A. General Areas: CSA rated, UL listed, braided stainless steel gas hose of size and capacity to meet appliance input requirements.
2.17 EXPANSION COMPENSATORS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ASME B31.1 for pressure piping. Vertical piping for domestic hot water, chilled water, heating water, steam and steam condensate shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not required packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.

B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Keflex #311 series or approved equal.

C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Metraflex #Metraloop or approved equal.

D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Metraflex #SST or approved equal.

E. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Metraflex #BBS or approved equal.

F. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Metraflex #Style IV or equal.

G. Expansion Loops: Provide field fabricated pipe expansion loops as detailed on the drawings or in place of mechanical expansion joints.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS
PLUMBING PIPING, VALVES AND SPECIALTIES

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION

A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised and made to the satisfaction of the Engineer.

B. The cooperative work not included in the Plumbing Division related to the general construction work is as follows:

1. All formed concrete work.
2. Framed openings in masonry and other Architectural and Structural elements.
3. Wood grounds and nailing strips in masonry and concrete.
4. Sloping of floors to drains and floor sinks.
5. Sloping of roof-to-roof drains and overflow drains.

C. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and visqueen cover to protect equipment and piping delivered to and stored at the site.

3.4 WORKING PRESSURES

A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.

B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.

C. Low pressure, 0.5 psig (14 inch Water Column) or less, Natural Gas Systems: Use 1/2 to 2-inch NPS: Gastite corrugated stainless steel tube and brass fittings.

D. Medium pressure, over 0.5 psig (14 inch Water Column) up to 5 psig, Natural Gas Systems: Use 1/2 to 2-inch NPS: Gastite corrugated stainless steel tube and brass fittings.

3.5 PIPES SIZES TO EQUIPMENT

A. General: Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.

B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.6 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16” misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2” where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate
PLUMBING PIPING, VALVES AND SPECIALTIES

insulated piping for 1" clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces. Route drip pan drain piping to floor drain, floor sink or other approved receptor.

3.7 WELDING

A. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation shall conform to ANSI 31.1 "Power Piping".

1. Submit for approval the names, identification, and welder’s assigned number, letter or symbol of welders assigned to this project.
2. The assigned identification symbol shall be used to identify the work of each welder and shall be indelibly stamped immediately upon completion of each weld.
3. Welders shall be tested and certified for all positions.
4. Submit identifying stenciled test coupons made by each operator.
5. Any or all welders may be required to retake welding certification tests without additional expense.
6. When so requested, a welder shall not be permitted to work as a welder on this project until he has been recertified in accordance with NCWB.
7. Recertification of the welder shall be made after the welder has taken and passed the required tests.
8. Where piping 1-1/2 inches and smaller is butt or socket welded, submit 3 samples of test welds for approval.

3.8 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings.

B. Provide joints of type indicated in each piping system.

C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM B-32, in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications, and shall meet CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.

1. Manufacturers:
   a. Solder: JW Harris "Bridgit" or Englehard "Silvabrite 100".
   b. Flux: Laco "Flux-Rite 90", MW Dunton "Nokorode CDA Flux", Hercules "Fluid Action Solder Flux".
PLUMBING PIPING, VALVES AND SPECIALTIES

E. Braze copper tube and fitting socket with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.

F. Corrugated stainless steel tube (CSST) fittings joints: Gastite® mechanical tube fittings manufactured from ASTM B16 type 360 brass whose design incorporates a double wall flare for gas-tight seal with Jacket Lock™, mechanical capture of the jacket for enhanced tubing protection.

G. Piping shall be capped during construction to prevent entry of foreign material.

H. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0°F.
   2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1" long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Refabricate to comply with requirements.
   6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install regular T-fitting.

I. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.


3.9 VALVES

A. General: Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided as necessary.
   2. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
   3. Install butterfly valves with stems mounted horizontally.
   4. All valves mounted higher than 7' above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6' above floor.
   5. Provide Seismic shut off valve on gas main downstream of meter.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
   1. Copper Pipe, 2-1/2" and Smaller: Soldered-joint valves.
   2. Steel Pipe, 2" and Smaller: Threaded joint valves.
   3. Larger Pipe Sizes: One of the following, at installer's option:
      a. Flanged valves
      b. Lug valves
PLUMBING PIPING, VALVES AND SPECIALTIES

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, ball, plug, circuit setter, globe, and butterfly valves to comply with ASME B31.9.

G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

H. Wafer Check: Install between 2 flanges in horizontal or vertical position.

I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception.

J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

K. Valve Identification: Tag each valve in accordance with "Mechanical Identification" section.

L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

3.10 TEMPERATURE GAUGES

A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gages to be installed with snubbers to absorb system shock.

B. Install in the following locations, and elsewhere as indicated:
   1. At outlet of hot water heaters
   2. At inlet and outlet of boilers

3.11 MECHANICAL SLEEVE SEALS

A. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

B. Fire Barrier Penetration Seals: Fill entire opening with sealing compound in compliance approved and listed UL system number. Adhere to manufacturer's installation instructions.

3.12 SUPPORTS AND HANGERS (See 15050)

3.13 EQUIPMENT RAILS AND PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.14 VIBRATION CONTROL ISOLATORS

A. Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

C. Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration control materials and units. Adjust to ensure that units have equal deflection,
PLUMBING PIPING, VALVES AND SPECIALTIES

do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.

D. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

E. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

F. Flexible Pipe Connectors: Install on equipment side of shutoff valves.

G. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

H. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.15 EXPANSION LOOPS

A. Expansion Loops: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.

B. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

3.16 EXPANSION COMPENSATORS

A. Install as noted on plans. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer's recommendations.

3.17 PIPE INSPECTIONS

A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e. “Rough-in” “top-out” and final.

B. Inspection – Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner’s Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

C. Inspection – Above Grade: All piping installed above grade shall be made available for inspection upon completion and prior to finish of walls and ceilings. Notify the Architect, the Owner’s Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to the desired inspection time. Should the piping be hidden within the structure prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.18 CLEANING, FLUSHING, DISINFECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

B. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports, and accessory items.

C. Inspect pressure piping in accordance with procedures of ASME B31.

D. Disinfect water mains and water service piping in accordance with Section 220501.
PLUMBING PIPING, VALVES AND SPECIALTIES

3.19 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The system may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. "Tolerance" shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times the system operating pressure or the listed test pressure below, whichever is greater:

<table>
<thead>
<tr>
<th>System</th>
<th>Test Medium</th>
<th>Test Pressure</th>
<th>Tolerance-Test Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>Water</td>
<td>150 psig</td>
<td>None – 8 hours</td>
</tr>
<tr>
<td>Soil and Waste</td>
<td>Water</td>
<td>10 ft head, 5 psi</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Vent</td>
<td>Water</td>
<td>Top of Vent Terminal</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Storm</td>
<td>Water</td>
<td>Top of Roof Drain</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Automatic Fire</td>
<td>Water</td>
<td>200 psig</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Air</td>
<td>100 psig</td>
<td>None – 24 hours</td>
</tr>
</tbody>
</table>

D. Final Drainage, Waste and Vent Test: Upon project closeout, Contractor shall perform and certify that the DWV system has passed the following test:

1. After all plumbing fixtures have been installed and their traps filled with water, all vent terminals and building drains shall be closed and a U-tube water manometer shall be inserted into the trap of water closet and an air compressor testing apparatus shall be attached to any suitable opening. An air pressure of 1" water column as indicated on the manometer shall be introduced into the system. The pressure shall hold constant for a period of 15 minutes without the introduction of additional air. Leaks revealed during this test may be located by smoke test of other recognition methods.

E. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.

F. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, air vents, trap primers, and vacuum breakers for proper performance. Test all air vent points to ensure that all air has been vented.

G. Backflow Preventers: Each testable backflow prevention device shall be tested and approved by certified testers after installation. Submit test results.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Domestic hot water recirculating pumps
   2. Sump pumps
   3. Sewage ejectors
   4. In-line circulators
   5. Expansion tanks - atmospheric.
   6. Expansion tanks - diaphragm type pre-pressurized.
   7. Air separators.
   8. Air elimination valve.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing
C. Section 224000: Plumbing Fixtures
D. Division 26: Electrical

1.4 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products.
B. Codes and Standards: Provide pumps which conform to the requirements of:
   1. Hydraulic Institute (HI): Manufacturer pumps in accordance with "Standards for Centrifugal Rotary and Reciprocating Pumps."
   2. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
   4. Underwriters Laboratories (UL): a. UL-778: Motor Operated Water Pumps

1.5 SUBMITTALS
A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
   1. Parallel pump plots: For all parallel and series pump applications submit a combined pump curve showing parallel pump operation and single pump non-overloaded operation verifying that the pump selections operate non-overloading on curve in a single pump operation.
   2. Submittal information to verify all scheduled characteristics are met including efficiency.
B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.
PUMPS AND SPECIALTIES

C. Maintenance Data:
1. Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists.
2. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

D. Wiring Diagrams:
1. Submit manufacturer’s ladder-type wiring diagrams for power and control wiring required.
2. Differentiate between factory-installed and field-installed wiring.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer’s stamp or label affixed.
B. Store and protect products and units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.
C. Rigging: Comply with the manufacturer’s rigging and installation instructions.

1.7 WARRANTY

A. Provide general one year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 HOT WATER RECIRCULATING PUMPS

A. Furnish and install pumps with capacities as shown on plans.
1. Pumps shall be in-line type for installation in vertical or horizontal piping.
2. Pump must be capable of being serviced without disturbing piping connections.
B. Pump body shall be of all bronze construction, rated 175 psi working pressure, with gauge ports at nozzles, and with vent and drain ports.
C. Impeller shall be non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.
D. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and carbon seal ring, suitable for continuous operation at 225°F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.
E. Pump bearing bracket shall have oil lubricated bronze journal and thrust bearings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibration shall be employed.
F. Motor shall meet NEMA specifications and shall be the size, voltage and enclosure called for on the plans.
G. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.
H. Provide H-O-A switch with overload protection. Pump shall be controlled by an aquastat on the return line and a flow switch on the cold water makeup. Wiring between switch and pump provided under Division 22, as stated in Section 220500.
I. Manufacturer: ITT Bell and Gossett Series 60, TACO, Thrush or Grundfos.

2.2 DUPLEX SUBMERSIBLE SEWAGE EJECTOR

A. Furnish and install where shown on the plans, one Weil Pump Co. duplex submersible sewage ejector system.
B. Pump(s) shall be Weil Series 2500 submersible type, with capacities as scheduled on plans.
C. The pump casing shall be one piece cast iron constructed with tripod support legs that provide an even distribution of weight.

D. The mating surfaces between the motor end bell, the motor shell and the seal chamber shall be sealed by means of "X" section QUAD RINGS. Designs using conventional circulate 'O' rings or rectangular cross sectional gaskets shall not be considered equal.

E. Pump motor shall be vertical, NEMA-6 and of an air filled, hermetically sealed design for premium efficiency. Oil filled shell shall not be considered equal.

F. Motor end bell shall be cast iron, designed as a terminal box and separated from the motor shell by a combination bearing support and inspection plate.

G. The motor shall be housed within a water tight, heavy duty cast iron shell with integral extended cooling fins. Motor shall have Class 'F' insulation and permanently lubricated, double sealed ball bearings having a minimum life of 17,500 hours. Motors using sleeve type bearings shall not be considered equal.

H. Motor shaft shall be 300 series stainless steel with keyway for positive positioning of impeller. Motors using carbon steel shafts or stainless stub shafts shall not be considered equal.

I. Impeller shall be multi-vane design, constructed of bronze, accurately machined and dynamically balanced to the job site conditions. The impeller shall not require the use of wearing rings to insure proper operation and shall be capable of passing 4 inch minimum solids.

J. A double mechanical seal system shall be furnished and housed in a machined cast iron seal chamber filled with clean dielectric oil, providing constant lubrication. Lower seal surfaces shall be of solid silicon carbide to provide longer life. Carbon ceramic, tungsten carbide or systems that allow the lower seal surfaces to come in contact with the pumped media, shall not be considered equal.

K. Each pump shall be tested and a computer generated report will be kept in file and made available upon request. The reported test data shall consist of six duty points of various heads and capacities, one of which will be the design point and shall include actual efficiencies and horsepower requirements.

L. Furnish remote packaged factory pre-wired duplex pump controller with the following:
   1. NEMA 1 double door dead front steel lockable enclosure.
   2. Magnetic starter with overload reset through cover, each pump.
   3. Fused disconnect switch with handle through cover, each pump.
   4. Automatic alternator, separately fused.
   5. Overload reset buttons, each pump.
   6. Running lights, each pump.
   7. H-O-A switches, each pump.
   8. Control circuit transformer for 120V operation for each pump.
   9. Output connection for hi-water annunciation at Simplex.
  10. Alarm silencing switch.
  11. Alarm light with flasher.
  12. Numbered and wired terminal strip.
  14. All wiring between control panel and pump provided under Division 22.

M. Furnish and install Weil Series 8230 mercury float switches complete with galvanized rod and wall support bracket. Each pump control switch will consist of 2 normally open mercury switches, encapsulated in epoxy resin. The float casing will be polypropylene. The switch cable will be type STO PVC jacket 4 #18 conductor. 41 strand, 600 volt insulation. The cable will be secured to the support rod with a polypropylene composition clamp with stainless steel bolts. Switches used for high water alarm service will be of the same construction as the pump switches, except that 2 conductor cables will be furnished. The switch housing will be color coded to distinguish between the pump and alarm switches.
1. All wiring between control panel and float switches provided under Division 22.

N. Warranty:
1. The pump manufacturer shall warrant the pumps being supplied to the owner against defects in workmanship and materials for a period of five (5) years under normal use, operation and service.
2. All repairs or replacement parts that may be needed after the initial sixteen months will be made and the cost (F.O.B. factory) pro rated for the period of time the pump has been in operation.
3. The warranty shall be in published form and apply to all similar units.

2.3 SIMPLEX SUMP PUMP SYSTEM - ELEVATOR SUMP APPLICATION
A. Provide where indicated on drawings, a Simplex submersible sump pump. Pump to have a 2" I.P.S. discharge, bronze fitted construction with submersible sealed motor, stainless steel shaft, bronze impeller, mechanical seal, and waterproof power cord. Pump to have 50 GPM flowrate minimum. Motors to be as scheduled. Pump shall have a fully submersible float switch for mounting on pump discharge pipe.
B. Provide with differential mercury float switches for (1) on-off operation and (2) high water alarm.
C. Provide check valve and shut-off valve on discharge side of pump.
D. Warranty: One year.
E. Manufacturer: Meyers S-25, Weil, Federal, Liberty or Zoeller.
F. High water alarm: Local alarm with dry contacts for connection to BMS.

2.4 EXPANSION TANKS
A. Atmospheric:
1. General: Tanks shall be constructed from carbon steel, in conformance with the requirements of ASME Code for a working pressure of 150 psi. Tank shall be fitted with Airtral tank fitting, an air-charging connection, drain valve, gauge glass, and shall include all tappings and supports. After fabrication all external surfaces of the tank shall be thoroughly cleaned and finished with one coat of air dry enamel.
2. Size and capacity as shown on drawings. Provide reducing valve and accessories as noted on plans or schedules.
3. Manufacturer: Bell & Gossett, TACO, Wheatley or approved equal.
B. Diaphragm Type Pre-pressurized:
1. The pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank.
2. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi and precharged to the minimum operating pressure.
3. The manufacturer shall be Wessels, Amtrol or approved equal with at least five years experience in the fabrication of diaphragm-type ASME expansion tanks.

2.5 AIR SEPARATORS
A. Tangential and coalescing media type:
1. All free air originally contained in the system, and all entrained air bubbles carried by system water shall be eliminated at all system points as indicated on the drawings.
2. The air separator shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi.
3. Air separators shall be sized as indicated on plans.
4. Provide with strainer unless otherwise noted.
5. Manufacturer: Bell & Gossett, TACO, Wheatley, Armstrong, Spirovent or approved equal.
6. Furnish and install as shown on the drawings a Spirotherm, Bell & Gossett, Wheatley, Armstrong, TACO, Amtrol or approved equal air separator on the HVAC circulating water systems.
7. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and entering velocity not to exceed 4 feet per second at specified GPM.
8. Units shall eliminate 99.6% of system air (including entrained air and microbubbles). Performance curves from the unit manufacturer shall be furnished as part of the submittal for each unit. Units may include internal copper coalescing medium to facilitate maximum air elimination and suppress turbulence or be furnished with galvanized steel strainer and stainless steel collector tube for a similar purpose.
9. Provide integral high capacity float actuated air vent at top fitting of tank or cast iron float actuated air vent rated at 150 psig which shall be threaded to the top of the separator. Unit shall have bottom blow down connection.

2.6 AIR ELIMINATION VALVE (AUTOMATIC)
A. Air shall be eliminated to the atmosphere as fast as it is separated from system water, through a float activated remote pressure operated, air elimination valve installed at the top of the air separator.
B. The air elimination valve shall have a high removal rate at low pressure differentials and shall be fully open for the removal of air at all pressures in the operating range from 2 to 150 psig. It shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations.
C. The air elimination valve shall be constructed of metal and all working parts shall be non-corrosive. Working pressure shall be 125 psi.
D. Provide minimum 3/8" drain line from vent and route to nearest floor drain or floor sink or other approved drainage location.
E. Manufacturer: Amtrol, Hoffman or approved equal.

PART 3 - EXECUTION
3.1 INSTALLATION
A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.
B. Grouting Pump Base: For all base mounted flexibly coupled pumps fill the pump base frame with grout after completing pump/motor alignment.
C. Provide vibration isolation, inertia bases, seismic snubber, flexible pipe connections, etc, as specified in related specification sections.
D. For variable flow pumping applications, see Section 230593 for additional requirements.
E. Contractor to assist testing and balancing contractor in verifying correct pump rotation and system operation.
F. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.
G. Isolation for Service: Provide pump installations with a discrete isolation valve on both the supply and intake side of the pump to permit service of the pump and any related strainer, check or balancing valves. Triple duty valves are not equivalent for this shut-off service.
H. Balancing Coordination and Impeller Trimming: Coordinate final pump flow with test and balance contractor. For pumps larger than 5 horsepower, if the system tests and balance indicate that flow exceeds the specified flow by greater than 20%, it is not acceptable to reduce flow merely by adjusting balance valves to create additional head or reducing VFD peak flows. Excess system flow must be reduced by trimming the impeller to match the load.

3.2 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the installation of plumbing fixtures and trim.

1.3 RELATED WORK IN OTHER SECTIONS
A. Section 220500: Basic Materials and Methods
B. Section 220501: Plumbing
C. Section 221123: Plumbing Equipment

1.4 SUBMITTALS
A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer's data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Plumbing fixtures
   2. Piping specialties
   3. Toilets
   4. Urinals
   5. Lavatories
   6. Sinks
   7. Drinking fountains

B. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages. Coordinate requirements with Architectural Woodwork shop drawings specified in Division 06 for fixtures installed in countertops and cabinets. Furnish templates for use in woodwork shop.

C. Samples: Submit samples of any piece of equipment requested by Architect for review and approval.

D. Wiring Diagrams: Submit manufacturer's electrical requirements and wiring diagrams for power supply to units. Clearly differentiate between portions of wiring that are factory installed and field installed portions.

1.5 CODES AND STANDARDS
A. Uniform Plumbing Code (UPC) with State Amendments
B. State of Oregon Plumbing Specialty Code – SOPSC
C. All fixtures and faucets must meet all requirements of the State of Oregon Structural Specialty Code – SOSSC
D. All fixtures and accessories must be approved for use by the State of Oregon
E. All fixtures and faucets must meet all requirements of Americans with Disabilities Act (ADA).
F. State Energy Code

1.6 DELIVERY, STORAGE, AND HANDLING
PLUMBING FIXTURES

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products. Remove damaged products from project site.

1.7 MAINTENANCE

A. Extra Stock:
1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures, flush valves, and trim to Owner with receipt in a quantity of one device for each 10 fixtures.
2. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, o-rings, sleeves, and seats in a quantity of 1 kit for each 10 faucets.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide fixtures as specified. Fixtures in any secure or public areas shall be vandal proofed.
B. Architect/Engineer shall review and approve any substitution requested by Contractor prior to bid submittal.
C. Provide fixture as specified, acceptable manufacturers:
2. Stainless Steel Sinks: Elkay or Just
   a. All stainless steel is 18 gauge, type 304 unless otherwise specified.
3. Drinking Fountains: Elkay or Haws.
4. Terrazzo Service Sinks: Florestone or Stern Williams.
5. Showers enclosures: Lasco, Fiber Fab, Aquaglass and Aqua Bath.
D. Provide faucet as specified. Acceptable manufacturers: Chicago Faucets, Zurn, Symmons, T and S or as indicated.
E. Provide a thermostatic mixing valve conforming to ASSE 1070 for all public lavatories.
F. Provide flush valve as specified. Acceptable manufacturers: Sloan or Zurn.
G. Provide commercial grade toilet seat as specified. Acceptable manufacturers: Beneke, Bemis, Church or Olsonite.
H. Provide heavy-duty cast iron commercial grade carrier as specified. Provide compact carriers where space is limited. Acceptable manufacturers: Ancon, Jay R. Smith, Wade or Zurn. No plastic parts on foundry items.
I. Provide heavy duty commercial grade 17-gauge P-Trap and supplies with stops as specified. Provide heavy duty commercial grade lavatory supplies. Provide supplies meeting AB1953 no lead requirements. Supplies shall be ½" x 3/8" x 12" ground joint flexible riser with loose key angle stop with chrome plated I.P.S. brass nipple. Sink supplies shall be ½" x 12" ground joint flexible riser with loose-key angle stop with chrome plated I.P.S. brass nipple. Provide bell type escutcheons for both P-trap and supplies. Acceptable manufacturers: Zurn, Brasscraft, Chicago, or McGuire.
1. P-trap - Lav: McGuire C8902-DF or Zurn Z-8701.
2. Supply for Lavatory: McGuire LFH2165LK or Zurn ZH88-XL-LK.
3. Offset supply for barrier free lavatory: McGuire 158 WC.
4. Supply for Water Closet: McGuire H2169LK or Zurn ZH-8807-CR.
5. Escutcheons: McGuire WE00D Series, wrought brass, bell type.
7. Barrier-free lavatory offset grid strainer: McGuire 155WC or Zurn 8746.

SERA Architects Inc. Package 4 - 50% Construction Documents
PLUMBING FIXTURES

J. Insulation: provide white molded closed cell vinyl pre-fab insulation on P-Trap and on both hot and cold water supply for barrier free lavatories and sinks. Acceptable manufacturers: Plumberex, True-Bro, and Zurn. Bag type insulators are not acceptable.

2.2 FIXTURE LISTING

A. WC-1 Water Closet – HET:
   1. Fixture: Kohler K-4325 wall hung, white vitreous china, elongated bowl, high efficiency siphon jet toilet.
   2. Seat: solid white plastic, elongated open front seat, less cover.
   3. Flush Valve: Sloan 111-1.28 flush valve.
   4. Mounting Height: 15” floor to bowl rim.

B. WC-2 Water Closet – HET – ADA:
   1. Fixture: Kohler K-4325 wall hung, white vitreous china, elongated bowl, high efficiency siphon jet toilet.
   2. Seat: solid white plastic, elongated open front seat, less cover.
   3. Flush Valve: Sloan 111-1.28 flush valve transformer.
   4. Mounting Height: 18” floor to top of seat.

C. UR-1 Urinal – Ultra low flow:
   1. Fixture: Zurn Z5755 ultra water saving wash down urinal.
   2. Flush Valve: Zurn ZEMS6003AV-ULF-IS with sensor operated valve P6000-HW6 with .125 GPF.
   3. Retrofit Flush Valve: Zurn ZEG6003EV sensor operated flush valve .125 GPF.
   4. Mounting Height: 24” floor to lip.

D. UR-2 Urinal – Ultra low flow, ADA:
   1. Fixture: Zurn Z5755 ultra water saving washdown urinal.
   2. Flush Valve: Zurn ZEMS6003AV-ULF-IS with sensor operated valve P6000-HW6 with .125 GPF.
   3. Retrofit Flush Valve: Zurn ZEG6003EV sensor operated flush valve .125 GPF.
   4. Mounting Height: 17” floor to lip.

E. L-1 Lavatory - Barrier Free:
   1. Fixture: Kohler K-2211 “Caxton,” 19” x 15” cast iron under counter mounted oval lavatory.
   2. Faucet: Kohler Faucet K-7516 with grid strainer, and outlet set @ 0.50 GPM, With K-13601 thermostatic mixing valve.
   3. Option 1 Faucet: TOTO: TEL5C10 Helix EcoPower with Mixing valve, outlet .5 GPM
   5. Mounting Height: 34” floor to bowl ledge, maximum.

F. L-2 Lavatory - Barrier Free:
   1. Fixture: Kohler K-2084 “Soho” 20” x 18” wall hung vitreous china lavatory drilled for concealed arm carrier.
   2. Faucet: Kohler Faucet K-7516 with grid strainer, and outlet set @ 0.50 GPM, With K-13601 thermostatic mixing valve.
   3. Option 1 Faucet: TOTO: TEL5C10 Helix EcoPower with Mixing valve, outlet .5 GPM
   5. Mounting Height: 34” floor to bowl ledge, maximum.

G. S-1 Sink:
   1. Fixture: Elkay #LRAD-2222-6 ½, 22"x22"x6 ½”, self-rimming countertop 18 gauge stainless steel single bowl sink.
   2. Faucet: Chicago 786 spread fitting w/ blade handles & gooseneck with Omni A-400-1.50 VR laminar flow set @ 1.5 G.P.M.
   3. Drain: Elkay, standard duo strainers with 4” tailpiece.
   4. Supplies: ½” flexible supplies with stops and escutcheon plate. Provide 1/4” flexible supply with stop for coffee maker.
PLUMBING FIXTURES

5. Mounting Height: Refer to architectural elevation details.

H. FSH-1 Foot Wash: Meditation room
3. J.R. Smith 2005YA or Zurn.

I. MS-1 Sink - Mop:
1. Fixture: Stern Williams CRS-2200BP, “Crescent” 28" x 28" x 12" terrazzo floor set receptor; cast brass drain with stainless steel strainer and tailpiece; 20 gauge stainless steel rim guard, splash guard.
2. Faucet: Chicago Faucet 897-RCF; wall mounted combination fitting with vacuum breaker and 6” spout, wall brace, threaded hose outlet and integral stops, rough chrome finish, flow control set to 2 gpm (Omni A-810-2.0VR).
3. Sealant: Caulk edges of basin with silicone sealant.

J. DF-1 Dual Height Drinking Fountain:
2. Mounting height: 36” to top of bubbler.

PART 3 - EXECUTION

3.1 GENERAL
A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.
C. Examine walls, floors and cabinets for suitable conditions where fixtures are to be installed.
D. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.
E. Comply with the installation requirements of ADA with respect to plumbing fixtures for the physically handicapped.
F. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.
G. Install a stop valve in an accessible location in the water connection to each fixture.
H. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.
I. Seal fixtures to walls and floors using silicone sealant as specified in Division 07. Match sealant color to fixture color.
J. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.
K. Inspect each installed unit for damage. Replace damaged fixtures.
L. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow stream.
M. Replace washers or cartridges of leaking or dripping faucets and stops.
N. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

O. During construction cover all installed fixtures, sinks, and water coolers with cardboard boxes and wrap with Visqueen.

P. Provide flush valve and faucet support behind wall.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
1. Compliance with all codes and standards applicable to this jurisdiction
2. Shop Drawings for Equipment
3. Coordination Documents
4. Record Drawings
5. Start-up Service and Building Commissioning
6. Instruction, Maintenance, and O & M Manuals
7. Work associated with Delivery, Storage, and Handling of products
8. Work associated with provision of Temporary Facilities
9. Preparation of Posted Operating Instructions
10. Meeting Project Safety and Indemnity requirements
11. Proper Cleaning and Closing
12. Supplying proper Warranty information
13. Supply specified Guarantee documentation
14. Design and provision of Supports and Anchors
15. Pipe Portals
16. Pipe Supports
17. Equipment Rails
18. Access Panels and Doors
19. Identification Markers
20. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK
A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete heating, ventilating, air conditioning systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and pipe lines and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

D. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

1.4 DESCRIPTION OF BID DOCUMENTS
A. Specifications:
1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
2. Before proceeding with work check and verify all dimensions.
3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
4. 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.
5. Where existing pipes, conduits and/or ducts prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts. Verify exact location and elevation of existing piping prior to any construction.
6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

1.5 DEFINITIONS

A. “Above Grade”: Not buried in the ground and not embedded in concrete slab on ground.
B. “Accessible”: Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.
C. “Actuating” or “Control” Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.
D. “Below Grade”: Buried in the ground or embedded in concrete slab on ground.
E. “Concealed”: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.
F. “Connect”: Complete hook-up of item with required service.
G. “Exposed”: Not installed underground or “concealed.”
H. “Furnish”: To supply equipment and products as specified.
I. “Indicated,” “Shown” or “Noted”: As indicated, shown or noted on Drawings or Specifications.
J. “Install”: To erect, mount and connect complete with related accessories.
K. “Motor Controllers”: Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.
L. “Piping”: Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
M. “Provide”: To supply, install and connect as specified for a complete, safe and operationally ready system.
N. “Reviewed,” “Satisfactory” or “Directed”: As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner.
O. “Rough-In”: Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.
P. “Shall”: An exhortation or command to complete the specified task.
Q. “Similar” or “Equal”: Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.
R. “Supply”: To purchase, procure, acquire and deliver complete with related accessories.
BASIC HVAC MATERIALS AND METHODS

S. “Typical” or “Typ”: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

T. “Will”: A desire to complete the specified task. Allows some flexibility in application as opposed to “Shall”.

U. “Wiring”: Raceway, fittings, wire, boxes and related items.

V. “Work”: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 23 Mechanical sections included herein.

B. Division 33: Utility Site Work.
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.
   1. All concrete work for Mechanical Division shall be included in Division 23 under the appropriate Sections and shall include:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.
      c. Coordination of floor drain and floor sink installations in sloped floors.

D. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal
   2. Sealants and caulking
   3. Firestopping

E. Division 09: Painting:
   1. Division 23 installers shall perform all painting, except where specifically stated otherwise in Division 09.
   2. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials
   3. Paint all exposed gas piping, interior and exterior to the building, yellow.

F. Division 10: Miscellaneous Metals.
   1. Exterior louvers and grilles shall be included in this Section.

G. Division 26: Electrical is related to work of:
   1. Power connections to all mechanical equipment

H. Division 28: Electronic Safety and Security is related to work of:
   1. Fire protection alarms and relays
   2. Smoke detector and monitoring
   3. Life Safety Systems

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 23 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All mechanical work shall comply with the Americans with Disabilities Act (ADA).
E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
      b. 2007 Oregon Mechanical Specialty Code (OMSC) based on 2009 International Mechanical Code (IMC) and 2009 International Fuel Gas Code (IFGC) with State Amendments
      c. 2008 Oregon Plumbing Code (OPC) based on 2006 Uniform Plumbing Code (UPC) with State Amendments
      d. 2010 Oregon Fire Code (Based on the 2009 International Fire Code)
      e. 2008 Oregon Electric Specialty Code (Based on the 2008 National Electric Code (NEC) with State Amendments
   2. Local, city, county and state codes and ordinances
   3. Local Bureau of Buildings
   4. Local Health Department
   5. Local and State Fire Prevention Districts
   6. State Administrative Codes

G. Provide in accordance with appropriate referenced standards of the following:
   1. NFPA - National Fire Protection Association
   2. AABC - Associated Air Balance Council
   3. CSA - Canadian Standards Association
   4. ADC - Air Diffuser Council
   5. AMCA - Air Moving and Conditioning Association
   6. ANSI - American National Standards Institute
   7. ARI - Air Conditioning and Refrigeration Institute
   8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
   9. ASME - American Society of Mechanical Engineers
   10. ASTM - American Society for Testing Materials
   11. AWS - American Welding Society
   12. FM - Factory Mutual
   13. MSS - Manufacturer's Standardization Society
   14. NEMA - National Electrical Manufacturer's Association
   15. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
   16. UL - Underwriter's Laboratories
   17. ADA - Americans with Disabilities Act
   18. ETL - Electrical Testing Laboratories

1.8 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be aluminum or Type 304 stainless steel sheet, not less than 20 USG (0.0375"), riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data.

B. Current Models. All work shall be as follows:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 23, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.
1.9 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.
B. Review contract documents and technical specifications for extent of new work to be provided.
C. Provide and pay for all permits, licenses, fees and inspections.
D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 233113 Air Distribution for a summary of requirements.
E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access.
F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 48 for rough-in requirements.
G. Coordinate mechanical equipment and materials installation with other building components.
H. Verify all dimensions by field measurements.
I. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
J. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
K. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
L. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.
M. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
N. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.
O. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.
P. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
Q. Coordinate with Owner in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.
R. All materials (such as insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved...
testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

S. Coordinate installation of floor drains and floor sinks with work of other trades, such that finished floor slopes to drains and floor sinks are flush with surrounding floor.

T. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.10 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include:
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the mechanical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the “Electrical Work”. Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.11 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.12 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.
C. The Contractor shall submit approved Shop Drawings and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.

D. Submittals and Shop Drawings:
   1. Submitting contract drawings to demonstrate compliance with the requirement for preparation of shop drawing will not be accepted.
   2. Paper Submittals: Provide submittal as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals
   4. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

1.13 UNIT PRICING SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.

B. Preliminary List of Materials and Unit Price Items: Within thirty (30) days after awarding of the Contract, submit to architect for preliminary approval a complete list of manufacturer's names and model numbers of proposed materials and equipment. Also include proposed list of unit price items for review.
   1. Indicate substituted items.
   2. Identify test and balancing agency.
   3. Identify independent testing laboratory for water analysis.

C. The Contractor shall submit with preliminary list of materials a unit price list for each item furnished on this project. Included with price shall be labor cost index.

D. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.14 COORDINATION DOCUMENTS

A. The Contractors shall prepare coordinated Shop Drawings or electronic versions thereof to coordinate the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be coordinated drawings using either Overlay Drawings showing each discipline on a single sheet or electronic documents intended for the same purpose. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings or electronic coordination should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The coordination work shall be prepared as follows:
   1. Two dimensional paper or AutoCAD/Revit based documents:
      a. The Sheet Metal (Mechanical) Contractor shall prepare Drawings to an accurate scale of 1/4” = 1'-0" or larger, on reproducible media sheets or AutoCAD files. Lettering shall be minimum 1/8” high. Provide a “Hold Harmless Release” to obtain paper or AutoCAD files of the HVAC design from the Architect, or Engineer. Drawings are to be same size as Contract Drawings and shall indicate location,
BASIC HVAC MATERIALS AND METHODS

Size and elevation above finished floor, of all HVAC equipment, ductwork, and piping. Plans shall also indicate proposed ceiling grid and lighting layout, as shown on electrical plans and reflected ceiling plans.

b. The Plumbing Contractor shall obtain reproducible plans or AutoCAD files from the Mechanical Contractor, and indicate all plumbing lines including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.

c. The Fire Protection Contractor shall obtain reproducible plans or AutoCAD files with the detailed mechanical and plumbing work shown. The Sprinkler Contractor shall indicate location of all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.

d. Plans are to incorporate all addenda items and change orders.

e. Distribute plans to all trades and provide additional coordination as needed.

2. Three dimensional or BIM based documents:

a. The Sheet Metal (Mechanical) Contractor shall prepare a three dimensional model of the work using the project BIM model. Provide a “Hold Harmless Release” to obtain the BIM model of the project structural, architectural, and HVAC design from the Architect. If a BIM model is not available use the available two-dimensional CAD files to construct a three dimensional model for coordination purposes.

b. The Plumbing Contractor shall provide BIM input to indicate all major plumbing lines exceeding 3” in diameter including fittings, hangers, access panels, valves, and bottom of pipe elevations above finished floor.

c. The Fire Protection Contractor shall provide BIM input information locating all sprinkler heads and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.

d. BIM models are to incorporate all addenda items and change orders.

C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

D. Provide means of access to all valves, dampers, controllers, operable devices, and other apparatus that may require adjustment or servicing.

E. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Architect of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

F. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

G. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.15 RECORD DRAWINGS

A. Before commencing installation, obtain an extra set of prints from Architect, marked “Record”. Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project:

1. Obtain a clean set of reproducibles from the Architect or Engineer, at cost plus, and transfer the revisions to these reproducibles in a neat and orderly fashion.

OR

2. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.

B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.
BASIC HVAC MATERIALS AND METHODS

C. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Refer also to Special Conditions in Division 01 for full scope of requirements.

1.16 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of air conditioning units, temperature controls, chillers, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

D. Refer to other Division 23 Sections for additional requirements.

1.17 INSTRUCTION, MAINTENANCE, AND O&M MANUALS

A. O&M Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Architect complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, bound in a durable binder. Refer to Division 01.

B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 23 to be no less than two hours for each piece of equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated and referenced in the training sessions.

1.18 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.19 TEMPORARY FACILITIES
BASIC HVAC MATERIALS AND METHODS

A. Refer to Division 01 for the requirements of temporary water and sewer for construction and safety. Provide temporary heating, air conditioning, ventilation, water, and sewer, etc. services as necessary during the construction period and as required to maintain operation of existing systems.

B. Temporary Heating for Commissioning Tests:
1. Provide temporary heating where needed to provide false load for commissioning tests.
2. Temporary heating may be from the permanent heating system of the project or from a dedicated temporary heating system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon what work in place or being installed.

C. Temporary Cooling for Commissioning Tests:
1. Provide temporary cooling where needed to provide false load for commissioning tests.
2. Temporary cooling may be from the permanent cooling system of the project or from a dedicated temporary cooling system. If temporary system is necessary, select facilities known to be safe and without deleterious effect upon the work in place or being installed.

1.20 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.21 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, Drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor’s safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.22 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.23 WARRANTIES

A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.
B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.24 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:
   1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
   2. ASCE 7-05: “American Society of Civil Engineers.”
   3. 2009 International Building Code (IBC)
   4. MSS Standard Compliance: Manufacturer’s Standardization Society (MSS).
   6. NFPA: Pamphlet number 13 and 14 for fire protection systems.
   7. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS types listed.
   1. Adjustable Steel Clevis Hangers: MSS Type 1.
   2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
   4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
      a. Plate: Unguided type.
      b. Plate: Guided type.
      c. Plate: Hold-down clamp type.
   5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
   6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
   7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
   8. Single Pipe Roller with Malleable Sockets: MSS Type 41.
BASIC HVAC MATERIALS AND METHODS

9. Adjustable Roller Hangers: MSS Type 43.
10. Pipe Roll Stands: MSS Type 44.
11. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp or equal.

D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed.
   1. Steel Turnbuckles: MSS Type 13.
   2. Steel Clevises: MSS Type 14.
   3. Swivel Turnbuckles: MSS Type 15.
   5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated, provide factory-fabricated building attachments of one of the following types listed.
   1. Concrete Inserts: HCI-MD (for metal deck) or HCI-WF (for wood forms) cast-in anchors by Hilti Inc. or MSS Type 18 or Blue Banger Hanger by Simpson Strong-Tie Co. Inc.
   2. Steel Brackets: One of the following for indicated loading:
      b. Medium Duty: MSS Type 32.
      c. Heavy Duty: MSS Type 33.
   3. Horizontal Travelers: MSS Type 58.
   4. Concrete Screw Anchors: KWIK HUS EZ-I by Hilti Inc., Titen HD (or Rod Hanger version) by Simpson Strong-Tie Co. Inc. or approved equal.

G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
   1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
   2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
   3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert. Alternately Polysiliconate Urethane with a minimum flexural strength of 60psi, fully encased in 360 PVC (1.524 mm thick)SNAPPITZ. Provide assembly of same thickness as adjoining insulation.
   4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain tubing and join insulation at clevis hangers and strut-mounted clamps. Klo-Shure Insulation Coupling or equal.

H. Miscellaneous Materials:
   1. Metal Framing: Provide products complying with NEMA STD ML1.
   2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.
   3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0
BASIC HVAC MATERIALS AND METHODS

parts sand by volume, with minimum amount of water required for placement and hydration.

4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.

5. Pipe Brackets: "HoldRite" copper plated brackets. Insulate brackets attached to metal studs with felt.

2.3 PIPE PORTALS

A. Where pipe portals are not provided by other sections of Specification, provide prefabricated insulated pipe portals as required for piping penetrating through the roof where shown on plans. Field built pipe portals are acceptable alternatives - provide detail of construction for review.

B. Standard pipe portals, unless otherwise noted, shall be constructed as follows:
   1. Curb shall be constructed of heavy gauge galvanized steel with continuous welds on shell seams.
   2. Insulation to be 1-½" thick, 3 lb density rigid fiberglass.
   3. Curb to have a raised 3" (minimum), 45° cant.
   4. Curb to have 1-1/2" x 1-1/2" wood nailer (minimum).
   5. Curb height to be 8" (minimum) above roof deck.
   6. Cant shall be raised to match roof insulation thickness.
   7. Cover or flashing to be constructed of galvanized steel or other suitable material to provide sturdy weather tight closure. Provide collars and rubber nipples with draw bands of sizes required by piping. Size curb, cover and nipples per manufacturer's recommendations.
   8. Manufacturer: Roof Products Systems or Pate.

2.4 PIPE STANDS

A. General Requirements for Pipe Stands: 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.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Plastic or stainless steel.
   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:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   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-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

G. Manufacturer: Pate, Roof Products Systems, Portable Pipe Hangers, Roof Top Blox, or Erico Caddy Pyramid.
2.5 ACCESS PANELS AND ACCESS DOORS

A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels are not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer or concealed valve, for fire and combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.6 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils are not acceptable.

B. Plastic Pipe Markers:
   2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1. Secure both ends of markers with color coded adhesive vinyl tape.
   3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
   4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

C. Plastic Duct Markers:
   1. Provide 4 1/2" x 6" laminated plastic, ANSI A13.1 color coded duct markers with white core lettering.
   2. Nomenclature: Include the following:
      a. Direction of air flow
   3. Duct service (supply, return, exhaust, etc.).
      a. Duct origin (from)
      b. Duct destination (to)
      c. Design cfm
   4. Provide a minimum of every 20 feet on all ducts with a diameter or width greater than 12".

D. Underground-Type Plastic Line Markers: Provide 6" wide x 4 mils thick multi-ply tape, consisting of solid metallic foil core between 2 layers of plastic tape. Markers to be permanent, bright colored, continuous printed, intended for direct burial service.

E. Valve Tags:
1. Brass Valve Tags: Provide 1 1/2" diameter 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Fill tag engraving with black enamel.

2. Plastic Laminate Valve Tags: Provide 3/32" thick engraved plastic laminate valve tags, with piping system abbreviations in 1/4" high letters and sequenced valve number 1/2" high, and with 5/32" hole for fasteners.

3. Valve Tag Fasteners: Provide solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

4. Access Panel Markers: Provide 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

5. Non-potable Water Tags: 1/16" thick, engraved, plastic tags as indicated on Drawings.

F. Plastic Equipment Signs:
1. Provide 4-1/2" x 6" plastic laminate sign, ANSI A.13 color coded with engraved white core lettering.

2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

G. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Inc., or Brimar.

2.7 ELECTRICAL
A. General:
1. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.

2. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.

3. Set and align all motors and drives in equipment specified herein.

4. Provide expanded metal or solid sheet metal guards on all V-belt drives to totally enclose the drive on all sides. Provide holes for tachometer readings. Support guards separately from rotating equipment.

5. Provide for all rotating shafts, couplings, etc., a solid sheet metal, inverted "U" cover over the entire length of the exposed shaft and support separately from rotating equipment.

6. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

B. Quality Assurance:
1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

C. Motors:
1. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment Specifications.

2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.

3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Unless otherwise noted on plans, all motors ½ HP or
BASIC HVAC MATERIALS AND METHODS

larger shall be rated for 208 or 460 volt, 3-phase, operation. Unless otherwise noted on plans, all motors less than 1/2 HP shall be rated for 120 volt, single phase operation.

4. Temperature Rating: Motor meets class B rise with class F insulation.
5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
   a. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer’s standards to suit specific application.
   b. VFD driven motors to be provided as inverter ready and equipped with a shaft grounding device, or inverter duty complying with NEMA Standard MG-1, Part 31 as supplied by same manufacturer as VFD.
   c. Bearings:
      1) Ball or roller bearings with inner and outer shaft seals.
      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      3) Designed to resist thrust loading where belt drives or other drives product lateral or axial thrust in motor.
      4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
      5) Enclosure Type:
         a) Open drip-proof (ODP) motors for indoor use in clean air environments.
         b) Totally enclosed fan cooled (TEFC) motors for outdoor use and indoor application in dirty environments.
         c) Totally enclosed air over (TEAO) motors for motors in the airstream of cooling towers and fluid coolers.
         d) Guarded drip-proof motors where exposed to contact by employees or building occupants.
         e) Weather protected Type I for outdoor use, Type II where not housed.
    d. Overload Protection: Built-in thermal overload protection where external overload protection is not provided and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
    e. Noise Rating: “Quiet.”
    f. Efficiency:
       1) Motors shall have a minimum efficiency per governing State or Federal codes, whichever is higher.
       2) Motors shall meet the NEMA premium efficiency standard
    g. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

D. Starters and Electrical Devices:
1. Motor Starter Characteristics:
   a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs.
   b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
2. Manual switches shall have pilot lights and all required switch positions for multi-speed motors. Overload Protection: Melting alloy or bi-metallic type thermal overload relays, sized according to actual operating current (field measured).
3. Magnetic Starters:
   a. Heavy duty, oil resistant, hand-off-auto (HOA), or as indicated, and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   b. Trip-free thermal overload relays, each phase, sized according to actual operating current (field measured).
   c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23 Controls sections.
BASIC HVAC MATERIALS AND METHODS

d. Built-in primary and secondary fused control circuit transformer, supplied from load side of equipment disconnect.
e. Externally operated manual reset.
f. Under-voltage release or protection for all motors over 20 hp.

4. Motor Connections: Liquid tight, flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Low Voltage Control Wiring:
1. General: 14 gauge, Type THHN, color coded, installed in conduit.
2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

F. Disconnect Switches:
1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the “OPEN” position; arc quenchers; capacity and characteristics as indicated.
2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

PART 3 - EXECUTION

3.1 GENERAL
A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS
A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.
1. If the contractor must deviate from the manufacturer’s recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.3 INSTALLATION
A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost. Coordinate wall and ceiling work with the General Contractor, and his subcontractors in locating ceiling air outlets, wall registers, etc.
B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 SUPPORTS AND HANGERS
A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.
B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides,
strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through opening at top of inserts.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

D. Install hangers, supports, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

E. Install hangers within 12 inches of every change in piping direction, end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Hangers shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one hanger is required.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. Support sprinkler piping and gas independently of other piping.

H. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

I. Hanger Spacing in accordance with following minimum schedules for support of individual pipes (other spacings and rod sizes may be used in accordance with the SMACNA Seismic Restraint Manual using a safety factor of five):

1. Steel Pipe (Water Filled):

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 1 1/4&quot;</td>
<td>5 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>1 1/2&quot; to 2&quot;</td>
<td>7 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2 1/2&quot; to 3&quot;</td>
<td>10 feet</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>4&quot; to 12&quot;</td>
<td>12 feet</td>
<td>5/8&quot;</td>
</tr>
</tbody>
</table>

2. Steel Pipe (Gas/Air Filled):

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 1 1/4&quot;</td>
<td>6 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>1 1/2&quot; and larger</td>
<td>10 feet</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

3. Copper Pipe:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 2&quot;</td>
<td>6 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2 1/2&quot; and larger</td>
<td>8 feet</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

4. Glass Pipe:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 2&quot;</td>
<td>6 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2 1/2&quot; and larger</td>
<td>8 feet</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

5. Plastic/Fiberglass Pipe:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; to 2&quot;</td>
<td>4 feet</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>2 1/2&quot; and larger</td>
<td>6 feet</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

6. Caulked Bell and Spigot and Glass Pipe: Provide hanger for each section of pipe, located at shoulder of bell. Where an excessive number of fittings are installed between hangers, provide additional reinforcing.
7. Trapeze support: Provide details stamped by a registered structural engineer for the project state indicating trapeze channels, support rod sizes, and spacing.

J. Sloping, Air Venting, and Draining:
1. Steam:
   a. Slope steam piping as specified and as indicated, true to line and grade, and free of traps and air pockets downward a minimum of ¼ inch per 10 ft of run in the direction of flow.
   b. Where horizontal piping must be reduced in size, use eccentric reducers that allow continuous uniform pitch along the bottom of the piping. Avoid concentric reducers in horizontal piping.
   c. Takeoffs from steam mains are to be taken from the top of the main preferably at a 45 degree angle.
   d. Where branch takeoffs are less than 10 feet in length, the branch line is to be pitched back ½ inch per 10 feet providing drip legs.

2. Chilled, heating, and condensing water:
   a. Connect all heating and chilled water branch piping to the bottom or side of their respective mains. Where connection must be made to the top of the main piping, make provision for venting of air.
   b. Provide drain valves and hose adapters at all low points in piping.
   c. Provide vents at all high points in water piping.

K. Provisions for Movement:
1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.

3. Insulated Piping: Comply with the following installation requirements:
   a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
   b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.
   c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

L. Installation of Anchors:
1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.

2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.

3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

4. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends.

M. Equipment Supports:
1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.

2. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

N. Adjusting:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.5 ROOF CURBS, EQUIPMENT RAILS, PIPE PORTALS

A. Install per manufacturer's instructions.
B. Coordinate with other trades so units are installed when roofing is being installed.
C. Verify roof insulation thickness and adjust raise of cant to match.

3.6 ELECTRICAL REQUIREMENTS

A. Mechanical Contractor shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.
B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.
C. Division 23 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

1. Division 23 Mechanical Responsibilities:
   a. MOTORS: Furnish and install all motors necessary for mechanical equipment.
   b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
   c. VARIABLE FREQUENCY DRIVES: Provide all VFD’s associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
   d. DISCONNECTS: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   e. CONTROLS: Division 23 Contractor (including the temperature controls subcontractor) is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
      1) Control relays necessary for controlling Division 23 equipment.
      2) Control transformers necessary for providing power to controls for Division 23 equipment.
      3) Line voltage thermostats.
      4) Low or non-load voltage control components.
      5) Remote bulb thermostats.
      6) Non-life safety related valve or damper actuators.
      7) Float switches.
      8) Solenoid valves, EP and PE switches.
      9) Refrigeration controls. (Division 26 provides power to refrigeration panels.)
   f. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
BASIC HVAC MATERIALS AND METHODS

a) Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for proof of closure. (See Section 233113.)

b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. (See Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.

2) Fire Sprinkler System: Division 23 is responsible for providing necessary controls including flow switches and alarm bells.

3) Specialized fire suppression systems: Division 23 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.

D. Division 26 has responsibilities for electrically powered or controlled mechanical equipment, which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

1. Division 26 Electrical Responsibilities:
   a. MOTORS: Provide the power wiring for the motors.
   b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.
   c. VARIABLE FREQUENCY DRIVES: Physically mount all VFD's, which are not specified to be installed on Division 23 factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 23. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to insure that the drive is shutdown simultaneously with motor.
   d. DISCONNECTS: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
   e. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.
   f. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire/Smoke Dampers: Division 26 is responsible for power wiring to the damper and as follows:
         a) Where these dampers are part of an integrated smoke control system Division 26 is responsible for providing the detectors and for all fire detection system wiring necessary to integrate dampers and related end switches into the system.
         b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. (See Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.
      2) Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.
      3) Specialized fire suppression systems: Division 26 is responsible for providing
2. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

3. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

4. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that “cutting-over” has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

5. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

6. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.7 PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1. Paint all exposed materials such as piping, ductwork, equipment, insulation, steel, etc. Exposed gas piping inside and outside the building shall be painted with two coats of “Rust-O-Leum” Yellow. The inside surface of visible ductwork above diffusers/grilles shall be painted flat black. Exposed copper indirect waste piping serving food service equipment shall be painted metallic chrome.

B. All exposed work under Division 23 shall receive either a factory finish or a field prime coat finish, except:
   1. Exposed copper piping.
   2. Aluminum jacketed outdoor insulated piping.

3.8 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:
   1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
   2. Locate pipe markers as follows:
      a. Near each valve and control device.
      b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
      c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
      d. At access doors, manholes, and similar access points which permit view of concealed piping.
BASIC HVAC MATERIALS AND METHODS

e. Near major equipment items and other points of origination and termination.
f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room. Vertically spaced at each story transversed.

C. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.

D. Ductwork Identification: A minimum of every 20' for all ductwork 12" or more in diameter or width.

E. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:
1. Main control and operating valves, including safety devices.
2. Meters, gauges, thermometers, and similar units.
3. Pumps, compressors, chillers, and similar motor-driven units.
4. Hot water system mixing valves and similar equipment.
5. Boilers, heat exchangers and similar equipment.
6. Fans, blowers, primary balancing dampers, and mixing boxes.
7. Packaged HVAC central-station and zone-type units.
8. Tanks and pressure vessels.
9. Strainers, filters, treatment systems and similar equipment.
10. Sprinkler and standpipe equipment.

F. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

3.9 VIBRATION AND DYNAMIC BALANCING

A. Vibration tolerances shall be as specified by the “International Research and Development Corporation”, Worthington, Ohio, measured by the displacement, peak to peak, as follows:
1. All Fans: Below severity chart labeled “FAIR”, maximum velocity of 0.0786 in/sec, peak.
2. Pump and Electric Motors: Below severity chart labeled “SLIGHTLY ROUGH”, maximum vibration velocity of 0.157 in/sec, peak.
3. Compressors: Same as pumps.

B. Correction shall be made to all equipment, which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.10 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Ductwork: Test all air quantities as specified in Section 230593 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.

C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 230593 – Testing, Adjusting and Balancing.

D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.

E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer’s representative shall perform all tests.
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK
A. Furnish and install a complete UL listed system of heaters, components, and controls to prevent pipe lines from freezing including:
   1. All other piping lines exposed to freezing, including but not limited to:
      a. Exterior Heating Water
      b. Exterior Chilled Water

1.2 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230700: HVAC Piping Insulation
C. Section 260533: Raceways and Boxes for Electrical Systems
D. Section 262726: Wiring Devices

1.3 QUALITY ASSURANCE
A. The manufacturer shall have over three years experience with self-regulating heating cables in the domestic hot water temperature maintenance application and be regularly engaged in the production of such equipment and be capable of providing complete catalog information on such products.
B. The heating cable and components must have a UL System Listing. The UL Listing must have been in effect for three years at the time of quote submission.
C. The heating cable and components must be Factory Mutual approved for installation in applications as shown in the construction documents.
D. The heating cable and components must comply with ANSI Standard 515 "Recommended Practice for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications".

1.4 SUBMITTALS
A. Prior to construction submit for approval all materials and equipment. Submit manufacturer's data, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:
   1. Catalog cut of all proposed components, including but not limited to
      a. Heat Trace Controller.
      b. Heat Trace Cable.
      c. Power Connections.
      d. Splice Connections.
      e. Tee Connections.
      f. Lighted End Seals.
   2. Installation manual for each component.
   3. Shop drawing of proposed installation showing number of heat trace circuits, watts/foot cable type for each circuit and components used.
   4. Forms for factory recommended Electrical Testing and Commissioning Documentation for the system.
   5. Spare Parts List.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site. Deliver products to the site in containers with manufacturer’s stamp or label affixed.
B. Store/protect products safely. Protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products - remove from project site.

1.6 WARRANTY
A. Provide one year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

1.7 DIVISION OF RESPONSIBILITY
A. Division 22: The Plumbing Contractor shall purchase all heat trace components as noted herein to provide a complete system. Heat trace cabling, associated fittings and accessories and heat trace signage shall be installed as part of the mechanical contractor’s scope of work including hiring an electrical contractor if the installation of the cabling needs to be performed by electricians. The mechanical contractor shall be responsible to perform all coordination with the electrical contractor in terms of scheduling, installation of equipment, etc.

B. Division 26: Above ground and underground branch circuit wiring to the heat trace power connection J-boxes from the heat trace controller/contactor panel(s) and incoming power to the controllers/contactors shall be installed and connected by Division 26. All testing and commissioning shall be done by Division 26.

PART 2 - PRODUCTS

2.1 ELECTRIC HEAT TRACING SYSTEM
A. Cable: The self-regulating heater shall consist of two (2) 16 AWG nickel coated, copper bus wires embedded in parallel in a self regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without over-heating and to be cut to length in the field. To provide a good ground path where none exists and to enhance the heater’s ruggedness, the heater shall have an outer braid of tinned copper and an outer jacket of modified polyolefin.

B. Self-regulating: In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90%. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40° F pipe temperature operation to 150° F pipe temperature operation.

C. Single or dual circuit heat-trace controllers, quantity as required for the length of heat trace cable required:

2.2 WATTAGE/VOLTAGE
A. The heater cable shall operate on line voltage of 120, 208, 220, 240, or 277 volts without the use of transformers. See floor plan and schedules for voltage.

B. The heater cable shall be installed according to the table below. The required heater output rating is in watts per foot at 50° F. Heater selection based on 1.5” fiberglass insulation on metal piping. Increase to next size wattage rating if less insulation is shown to be required or 208V is used due to its required derating from its base rating of 240V.

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>MIN. AMBIENT -10°F</th>
<th>TEMPERATURES -20°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>3” or less</td>
<td>5 watt</td>
<td>5 watt</td>
</tr>
<tr>
<td>4”</td>
<td>5 watt</td>
<td>8 watt</td>
</tr>
<tr>
<td>6”</td>
<td>8 watt</td>
<td>8 watt</td>
</tr>
<tr>
<td>8”</td>
<td>2 strips - 5 watt</td>
<td>2 strips - 8 watt</td>
</tr>
<tr>
<td>10”</td>
<td>2 strips - 5 watt</td>
<td>2 strips - 8 watt</td>
</tr>
<tr>
<td>12” to 14”</td>
<td>2 strips - 8 watt</td>
<td>2 strips - 8 watt</td>
</tr>
</tbody>
</table>

C. The maximum heater cable lengths per circuit breaker, size noted, shall be installed according to the table below: If a required heat trace cable circuit length exceeds the values below then divide...
ELECTRIC HEAT TRACING

Divide the cable length into equal parts. Inform electrical contractor the required number of output circuits/ connection points. This chart is based on Raychem BTV cable.

<table>
<thead>
<tr>
<th>Cable</th>
<th>Breaker Size</th>
<th>Start up Temp</th>
<th>Voltage</th>
<th>Max Length per Breaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTV</td>
<td>30A</td>
<td>0°F</td>
<td>208, 2 pole</td>
<td>495'</td>
</tr>
</tbody>
</table>

2.3 GROUND FAULT EQUIPMENT PROTECTION

A. Where individual heat trace circuits are shown not connected to a control panel that includes 30mA ground fault circuit breakers (GFEPD) AND if not shown in the Division 26 panel schedules or if other sizes are required, then provide as part of this Division 23 scope of work.

B. Heat trace controllers have integral ground fault protection.

2.4 MANUFACTURER

A. The heat tracing system shall be manufactured by Raychem Corporation only: provide the above-insulation installed components as listed below:

1. Ordinary Area Location Electrical Components:
   a. Heat trace Controller: DigiTrace 910 controller in an 8" x 10" FRP enclosure with window. 2-pole 30 A EMR. Controls a single circuit with a 2-pole electromechanical relay. (Approved for nonhazardous areas only)
   
2. Heat Race Controller: Where two circuits are required provide DigitTrace 920 with same specs as above unit.

3. Power connection kit with J-box and LED light end seals: Rayclic-P Series, if two cables are required than use the dual exit fitting. RayClic-LE – lighted end seal

4. Industrial Heating Cable: Tyco Raychem BTV-C-CR or equal by Nelson

5. Fiberglass installation tape: GT-66 for installation above 40° F.

6. Aluminum tape for use on plastic piping.

B. Signage:


PART 3 - EXECUTION

3.1 INSTALLATION

A. Cable Installation:

1. Apply the heater linearly on the pipe after piping has been successfully pressure tested. Do not spiral wrap except at valves and heat sinks. Installation shall be as detailed in the manufacturer's installation instructions.

2. Secure the heater to piping with fiberglass tape at one foot intervals per the detail on the drawings. Do NOT use metal attachments, tie wire, or hose clamps to secure cable to the pipe. Verify correct fiberglass tape selection based on ambient temperatures.

3. Lighted End Seal: Mount J-box at the free end of every heating cable.

4. Cable Slack: When determining length of heating cable make allowances for extra cable around heat sinks such as supports and valves and for service loops at connections. Leave 18 inches of heating cable at the power connection, at all sides of splices and tees, and at the end seal to provide for service loops; except on pipes smaller than 1 inch, where 9 inches shall be provided.

5. Sealing: Seal all joints with sealing compound. All places where valves stems, conduits, connection enclosures, and other components that penetrate through the insulation jacketing must be sealed with a suitable sealing compound to keep water out. Ensure that the edges of these clearance holes and cable transitions do not rub on the cable and cause mechanical damage.

B. Electrical Connections:
ELECTRIC HEAT TRACING

1. The mechanical contractor shall use the following table to determine the required amount of heat trace cabling required.

2. Re-use of a grommet, or use of the wrong grommet, can cause leaks, cracked components, shock or fire. Use a new grommet whenever the cable has been pulled out of the termination. Verify that the proper grommets are used by checking the installation instructions supplied with the connection kit being installed. Connection kits should be mounted on top of the pipe when practical.

3. Electrical branch circuit conduit leading to power connection kits must be sloped away from kit to avoid condensation entry into the heating system. Use one single entry kit per circuit. Install conduit drain on branch circuit conduit.

4. Heat Trace controller RTD Sensor has a 10'-0" lead length, it location of sensor is greater than 10'-0" away from the controller than provide a 3-conductor, #16 AWG, shielded cable in EMT conduit to extend the sensor wiring.

5. All hot and neutral conductors downstream of controller serving heat trace cabling shall use cross-linked polyethylene insulated copper conductors with dielectric constant of 3 one-way circuit length exceeds 50'; 600V type XLP typical. This is to limit ground fault leakage.

6. Mount controller RTD temperature sensor outside on wall in the shade of the overhang in the location shown.

C. Signage: Apply "HEAT TRACED" signs to the outside of the thermal insulation on alternate side every 10 feet and at all changes in direction. Use 2" high letters on pipes greater than 3" outside diameter including insulation. Use 3/4" high letters on pipes smaller than 2 ½" outside diameter.

3.2 TESTING AND COMMISSIONING

A. Before cable installation (on roll), after cable installation and again after the installation of the thermal insulation, subject heat trace cable to testing using three voltages – 500, 1000 and 2500 VDC meger as discussed in ANSI IEEE Standard 141. A clean dry, properly installed circuit should measure thousands of megohms, regardless of the heating cable length or measuring voltage (0-2500VDC). The following criteria are provided to assist in determining the acceptability of an installation where optimum conditions may apply:
   1. All insulation resistance values should be greater than 1000 megohms.
   2. Insulation resistance values should not vary more than 25 percent as a function of measuring voltage for Test A and Test B.

B. Division 26 shall test for both heating cable bus wires to verify the connection of any splices of tees.

C. Document all tests on Engineer provided test forms, if provided or manufacturer’s forms if not provided. Completed forms shall be submitted to Engineer after initial installation test is complete and after final testing. All forms shall be included in the Operation & Maintenance (O&M) manuals.

3.3 INSPECTIONS

A. The Mechanical and Electrical Contractor are responsible to notify the Electrical Engineer one week prior to installation of insulation in order to inspect the system. At the time of the inspection the electrical contractor shall have written documentation of the meger tests on the Engineer provided forms. Ladders, man lifts or scaffolding shall be provided by the mechanical contractor to allow for inspection of all heat tracing components.

B. The Mechanical Contractor is responsible to notify the electrical engineer as soon as possible after installation of insulation and sealing of all joints is 100% complete in order to inspect the system. Ladders, man lifts or scaffolding shall be provided by the mechanical contractor to allow for inspection of all heat tracing components.

3.4 COORDINATION
ELECTRIC HEAT TRACING

A. Mechanical Contractor is responsible to coordinate installation of heat tracing with Electrical Contractor and all subcontractors.

END OF SECTION
## Electric Heat Tracing

**Testing and Commissioning Inspection Record**

**Copy and fill out this form for each heat trace cable circuit.**

<table>
<thead>
<tr>
<th>CIRCUIT NUMBER:</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATING CABLE TYPE:</td>
</tr>
<tr>
<td>CIRCUIT LENGTH:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inspection date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection inside connection boxes for signs of overheating, corrosion, moisture, loose connections, and other problems.*</td>
</tr>
<tr>
<td>Proper electrical connection, ground, and bus wires insulated over full length.*</td>
</tr>
<tr>
<td>Damaged or wet thermal insulation; damaged, missing, or cracked lagging or weatherproofing; gaps in caulking.</td>
</tr>
<tr>
<td>End seal, covered splices, and tees properly labeled on insulation cladding.*</td>
</tr>
<tr>
<td>Thermostats checked for moisture, corrosion, set point, switch operation, capillary damage, and protection.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Megohmmeter test</th>
<th>Ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test A 500 V</td>
<td></td>
</tr>
<tr>
<td>1000 V</td>
<td></td>
</tr>
<tr>
<td>2500 V</td>
<td></td>
</tr>
<tr>
<td>Test B 500 V</td>
<td></td>
</tr>
<tr>
<td>1000 V</td>
<td></td>
</tr>
<tr>
<td>2500 V</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit voltage Panel</td>
</tr>
<tr>
<td>Circuit end*</td>
</tr>
<tr>
<td>Circuit amps after 10 min.</td>
</tr>
<tr>
<td>Pipe temperature (°F)</td>
</tr>
<tr>
<td>Power = Volts x amps/ft</td>
</tr>
</tbody>
</table>

* Commissioning testing only.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, 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:
1. Vibration Isolation pads.
2. Vibration Isolation mounts.
3. Restrained uni-directional seismic isolation snubber mounts.
4. Spring isolators.
5. Housed seismic spring vibration mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
12. Seismic snubbers.
13. Seismic Restraining braces and cable systems for equipment, piping, and ductwork.
15. Flexible piping connectors
16. Flexible ductwork connectors

1.3 DEFINITIONS
A. Retain abbreviations that remain after this Section has been edited.
D. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS
A. Wind-Restraint Loading:
1. Basic Wind Speed: 95mph
2. Occupancy Category: III
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: C
2. Seismic Design Category as Defined in the IBC: D
   a. Component Importance Factor: Per section 13.1.3 of ASCE
   b. Component Response Modification Factor: Seismic engineer shall reference table 13.6-1 of ASCE 7-05 and select and submit appropriate values for each equipment and sub-system and material type for the project, and shall base the seismic calculations on these values.
   c. Component Amplification Factor: Seismic engineer shall reference table 13.6-1 of ASCE 7-05 and select and submit appropriate values for each equipment and sub-system and material type for the project, and shall base the seismic calculations on these values.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): Ss=0.067
4. Design Spectral Response Acceleration at 1-Second Period: S1=0.33

SERA Architects Inc. Package 4 - 50% Construction Documents
1.5 SUBMITTALS

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. 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 or agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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 static and dynamic loading due to equipment weight and operation, seismic and where required wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
   2. 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.
   3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
   4. Seismic and Wind-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic and wind restraints include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
      c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
      d. Preapproval and Evaluation Documentation: By an evaluation service or agency acceptable to the authorities having jurisdiction showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination and plan locations of seismic bracing for HVAC piping, ductwork, and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Evidence of Approvals: Provide California OSHPD approval number for each product. Do not submit products that have not received an OSHPD number.

E. Qualification Data: Devices shall be selected to meet seismic and support requirements by a registered professional Civil or Structural Engineer licensed in the State of the project.

F. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent test agency.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

G. Field quality-control Special Inspections: (For jurisdictions using the IBC).
   1. Required for anchorage of equipment in structures assigned to Seismic Design Category C, D, E, or F including
      a. Electrical equipment for emergency or standby power systems
      b. Piping systems intended to carry flammable, combustible or highly toxic contents in structures.
      c. Ductwork intended to contain hazardous materials.
      d. Special inspections of mechanical and electrical components
         1) Manufacturers of components defined with a component importance factor of 1.5 shall test or analyze the component and its mounting system or anchorage for the design forces experienced in the facility. The manufacturer shall submit a certificate of compliance. Components required to meet this requirement are:
            a) Equipment using combustible energy sources (boilers).
            b) Motors, transformers, switchgear unit substations, and MCC.
            c) Reciprocating and rotating-type machinery.
            d) Piping distribution systems 3 inch and larger.
            e) Tanks, heat exchangers, and pressure vessels.
      e. Isolation system: Shall be part of the special inspection if used as part of the seismic isolation system of components meeting importance factor as defined in the code.

H. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 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, IAPMO UES, 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. Building Structural Limits:
   1. The design of the seismic restraints shall not exceed the following building structure allowable point loads. The restraint design, whether permanent gravity induced loads or short term earthquake loads, shall not exceed the weakest component or configuration of components within the restraint assembly and/or the building structure limits identified below (The capacities listed below may be increased 1/3 for seismic induced loads):
      a. Metal Decking Concrete Filled: 1000 pounds
      b. Metal Decking Without Fill: 150 pounds
      c. Steel Beam, horizontal load applied to the upper 1/3 of Web, in a direction perpendicular to the span direction of the beam: 1,350 pounds
      d. Steel Beam Lower 2/3 of web, design loads shall not exceed 10% of the load identified for Upper 1/3 of the Web.
2.1 GENERAL REQUIREMENTS AND APPLICATION

A. Factory Finishes:
   1. Standard paint applied to factory-assembled and -tested equipment before shipping.
   2. Powder coating on springs and housings.
   3. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
   4. Baked enamel or powder coat for metal components on isolators for interior use.

B. Key to Device Schedule: Part 3 of this Section schedules the application of devices described in Part 2 for use with mechanical equipment found on this project. The designation of devices is as follows:

<table>
<thead>
<tr>
<th>TAG</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>Vibration isolation waffle pad</td>
</tr>
<tr>
<td>P-2</td>
<td>Double Deflection Neoprene mount</td>
</tr>
<tr>
<td>P-3</td>
<td>Uni-directional Restrained Neoprene snubber mount</td>
</tr>
<tr>
<td>S-1</td>
<td>Open spring vibration isolator</td>
</tr>
<tr>
<td>S-2</td>
<td>Steel housed seismic spring vibration isolator</td>
</tr>
<tr>
<td>H-1</td>
<td>Spring and rubber in shear vibration isolation hanger</td>
</tr>
<tr>
<td>Na</td>
<td>Resilient pipe riser support and guide</td>
</tr>
<tr>
<td>C-1</td>
<td>Seismic spring isolation roof curb (20 ton HVAC and below)</td>
</tr>
<tr>
<td>C-2</td>
<td>Seismic spring isolation roof curb (Greater than 20 ton HVAC)</td>
</tr>
<tr>
<td>C-3</td>
<td>Seismic braced non-spring isolation roof curb</td>
</tr>
<tr>
<td>B-1</td>
<td>Integral steel fan and motor base</td>
</tr>
<tr>
<td>B-2</td>
<td>Concrete filled steel inertia base</td>
</tr>
<tr>
<td>F-1</td>
<td>Kevlar/rubber spherical type flexible piping coupling</td>
</tr>
<tr>
<td>F-2</td>
<td>Stainless hose flexible piping coupling</td>
</tr>
<tr>
<td>F-3</td>
<td>Flexible ductwork connector</td>
</tr>
</tbody>
</table>

2.2 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
   1. Amber/Booth Company, Inc.
   2. California Dynamics Corporation.
   5. Vibration Eliminator Co., Inc.
   7. Vibration Mountings & Controls, Inc
   8. Vibro-Acoustics, Inc
   9. Vibrex

B. “Waffle” Pads (P-1): Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant rubber.
   2. Product Selection Basis: Mason SW or Vibro-Acoustics N.

C. Mounts (P-2): 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 base plate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

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.

3. Product Selection Basis: Mason ND or Vibro-Acoustics RD.

D. Restrained Mounts (P-3): All-directional snubber 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.

3. Product Selection Basis: Mason ND or Vibro-Acoustics RD.

E. Spring Vibration Isolators (S-1): 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. Base plates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to base plate underside. Base plates shall limit floor load to 500 psig (3447 kPa).

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

7. Product Selection Basis: Mason SLF or Vibro-Acoustics FS.

F. Seismic Restrained Spring Vibration Isolators (S-2): Freestanding, steel, captured spring isolators with seismic or limit-stop restraint.

1. Housing: Steel or cast iron with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled base plate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to base plate 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.

7. Product Selection Basis: Mason SLR, SSLFH or Vibro-Acoustics SFS.

G. Spring Vibration Hangers (H-1): 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.
8. Product Selection Basis: Mason 30N or Vibro-Acoustics SHR.

2.3 PIPE GUIDES AND SUPPORTS
A. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) 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 (3.45 MPa) and for equal resistance in all directions.
B. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) 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.

2.4 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-1) (HVAC UNITS 20 TON AND UNDER CAPACITY)
A. Curb mounted rooftop equipment shall be mounted on vibration isolation curbs. Curbs shall consist of continuous steel frames above and below isolators. Isolators shall be adjustable, freestanding and laterally stable and include a 1/4-inch acoustical neoprene cup and leveling bolts.
B. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load with 50% additional travel to solid.
C. A continuous sheet metal flashing shall be attached to the upper frame and be separated from the lower frame by a neoprene weather seal. Sheet metal flashing shall incorporate removable cover plates for adjustment and inspection of isolators after the unit is set. The unit must be solidly fastened to the top steel frame and the lower sheet metal curb must be attached to the roof structure.
D. Complete curb shall have an anchorage pre-approval "R" from OSHPD in the state of California attesting to the maximum certified horizontal and vertical load ratings.
E. Product Selection Basis: Curb shall be type ISC as manufactured by Mason Industries, Inc. or type VCR by Vibro-Acoustics, Inc.

2.5 SEISMIC RESTRAINED SPRING VIBRATION ISOLATION ROOF-CURB (C-2) (HVAC UNITS OVER 20 TON CAPACITY)
A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
5. Mason Industries.
6. Thybar Corporation.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc
B. General Requirements for Restrained Vibration Isolation Roof-Curb Rails:
1. Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
2. Curb shall have an anchorage pre-approval "R" number from OSHPD in the state of California attesting to the maximum certified horizontal and vertical load ratings. Brace
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

assemblies and rod clamps shall have an Anchorage Pre-approval "R" Number from
OSHPD in the State of California verifying the maximum certified load ratings

C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- (6-mm-) thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and/or wind restraint.
   a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
   b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.
   a. Resilient Material: Oil- and water-resistant

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

G. Acoustic Option: The upper floating frame of the roof curb shall have a steel framework that supports 2 layers of 5/8" thick waterproof gypsum board. Gypsum board must surround ducts to provide a continuous sound break. This acoustical barrier shall be caulked to minimize sound transmission. A 4" thick layer of 1.5-density fiberglass shall cover the entire solid roof surface under the unit. Gypsum board and insulation provided in field by contractor.

H. Product Selection Basis: Curb shall be type RSC-db as manufactured by Mason Industries, Inc. or type VCR w/ Acoustic Package by Vibro-Acoustics, Inc.

2.6 SEISMIC RESTRAINED ROOF-CURB (C-3)

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
   1. Amber/Booth Company, Inc.
   2. California Dynamics Corporation.
   3. Isolation Technology, Inc.
   5. Mason Industries.
   6. Thybar Corporation.
   7. Vibration Eliminator Co., Inc.
   8. Vibration Isolation.
   9. Vibration Mountings & Controls, Inc

B. General Requirements for Restrained Roof-Curb Rails:
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

1. Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

2. Curb shall have an anchorage pre-approval “R” number from OSHPD in the state of California attesting to the maximum certified horizontal and vertical load ratings. Brace assemblies and rod clamps shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings

C. Lower Support Assembly: Formed sheet-metal. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.

1. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.
   a. Resilient Material: Oil- and water-resistant

D. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

E. Product Selection Basis: Thycurb TC-3 or Vibro-Acoustics RTR

2.7 VIBRATION ISOLATION STEEL EQUIPMENT BASES

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 comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
5. Mason Industries.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc

D. Steel Base (B-1): Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) 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 A36/A36M. 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. Product Selection Basis: Mason MSL or Vibro-Acoustics SB


1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) 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 A36/A36M. Bases shall have shape to accommodate supported equipment.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND 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.

5. Product Selection Basis: Mason KSL or Vibro-Acoustics CIB

2.8 SEISMIC-BRACING/RESTRAINT DEVICES/SYSTEMS FOR EQUIPMENT, PIPING, AND DUCTWORK.

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. Amber/Booth Company, Inc.
2. California Dynamics Corporation
3. Cooper B-Line, Inc.
4. Hilti, Inc.
5. Kinetics Noise Control
7. Mason Industries
8. Tolco Incorporated
9. Unistrut
10. ISAT, Inc

C. 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.

D. 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 (6-mm) air gap, and minimum 1/4 -inch- (6-mm-) thick resilient cushion.

E. 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.

F. Sway Bracing: All suspended piping, ductwork, conduit and cable trays shall be provided with seismic sway braces in accordance with the applicable codes.

1. Seismic sway braces shall consist of galvanized steel aircraft cables or steel angles/strut channels. Steel aircraft cables shall be pre-stretched to establish a certified minimum modulus of elasticity. Cables braces shall be designed to resist seismic tension loads and steel braces shall be designed to resist both tension and compression loads with a minimum safety factor of 2. Brace end connections shall be steel assemblies that swivel to the final installation angle. Do not mix cable and steel braces to brace the same system. Steel angles or strut channels, when required, shall be clamped to the threaded hanger rods at the seismic sway brace locations utilizing a minimum of two ductile iron clamps. The bracing system shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California verifying its capability to resist seismic forces.

2. Basis of Design: Cable brace assemblies shall be Type SCB, steel brace assemblies shall be Type SSBS, rod clamps shall be either Type SRC or UC, pipe clevis braces shall
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

be Type CCB and multiple anchor load distribution brackets shall be Type SLDB all as manufactured by Mason Industries, Inc. or Type RSK cable brace assemblies and Type VAC rod clamps by Vibro-Acoustics.

G. Hanger Rod Stiffener: Steel tube, steel slotted support system sleeve or reinforcing steel angle clamped to hanger rod are acceptable.

H. 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.

I. 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.

J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

K. 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.

L. 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.

2.9 FLEXIBLE PIPING CONNECTORS

A. Flexible Spherical Joint (F-1): Flexible spherical joints shall employ peroxide cured EPDM in the covers, liners and Kevlar tire cord frictioning. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190F with a uniform drop in allowable pressure to 190 psi at 250F. 16" and larger connectors are rated 180 psi at 190F and 135 psi at 250F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Manufacturer: Mason Industries #SFDEJ, SFEJ, SFDCR, SFU and CR or Vibro-Acoustics EED.

B. Stainless Hoses: (F-2) Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Hoses must have sufficient length to accept 1/2" intermittent motion without failure. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Manufacturer: Mason Industries #BSS or Vibro-Acoustics SMP.

2.10 FLEXIBLE DUCTWORK CONNECTORS
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

A. Flexible ductwork connection (F-3): Flexible fiberglass canvas with fire resistant rated neoprene and UV resistant coating. Stainless steel metal edge banding. Minimum 4” width: DuroDyne “Durolon” or “Neoprene”.

PART 3 - EXECUTION

3.1 LOCATION AND APPLICATION OF VIBRATION ISOLATION EQUIPMENT

Table 1 below is a tool for selecting appropriate isolators, bases, and deflection. The engineer should edit the table to include equipment tags for all isolated equipment then edit the table to delete equipment types not found on the project. Alternately, incorporate the isolator, deflection, and base information found in the table on the equipment schedules on drawings and delete here.

A. Chart Table 1 schedules vibration devices required for isolation of mechanical equipment provided on the project. Refer to Part 2 above for device specifications.

B. Air Handling Units Equipment Isolation

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>EQUIPMENT</th>
<th>CRITICAL (35’ - 50’ SPAN)</th>
<th>UPPER STORY (20’ - 35’ SPAN)</th>
<th>ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A’</td>
<td>B’</td>
<td>C’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
</tr>
<tr>
<td>Floor Mounted</td>
<td>Up to 15 HP</td>
<td>S-1 (1)</td>
<td>1.5</td>
<td>B-1 (1)</td>
</tr>
<tr>
<td></td>
<td>20 HP &amp; Over</td>
<td>S-1 (1)</td>
<td>2.5</td>
<td>B-1 (1)</td>
</tr>
<tr>
<td>Suspended (4)</td>
<td>Up to 15 HP</td>
<td>H-1</td>
<td>1.75</td>
<td>B-1 (1)</td>
</tr>
<tr>
<td></td>
<td>20 HP &amp; Over</td>
<td>H-1</td>
<td>2.5</td>
<td>B-1 (1)</td>
</tr>
</tbody>
</table>

Notes:
(1) Provided by equipment manufacturer factory installed.
(2) Provide full perimeter steel welded frame below equipment
(3) Provide support per manufacturer’s recommendation
(4) Where internally isolated, hard pipe and duct connections to fan are allowed. If not internally isolated, provide F-2 pipe and F-3 duct connectors.

C. Unhoused Fans, Built-up Systems or Cabinet Fans Equipment Isolation

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>EQUIPMENT</th>
<th>CRITICAL (35’ - 50’ SPAN)</th>
<th>UPPER STORY (20’ - 35’ SPAN)</th>
<th>ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A’</td>
<td>B’</td>
<td>C’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
</tr>
<tr>
<td>CENTRIFUGAL FANS</td>
<td>Up to 15 HP</td>
<td>S - 2/S -</td>
<td>1.5</td>
<td>B-1</td>
</tr>
</tbody>
</table>
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2 – 50 HP</th>
<th>60 HP &amp; Over</th>
<th>S-2/S-1</th>
<th>1.5</th>
<th>S-2/S-1</th>
<th>0.75</th>
<th>B-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FANS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CL I &amp; II 60'W.D &amp; OVER/ALL CL III</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>S-2/S-1</td>
<td>1.5</td>
<td>S-2/S-1</td>
<td>0.75</td>
<td>B-1</td>
</tr>
<tr>
<td>20 – 50 HP</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>S-2</td>
<td>2.5</td>
<td>S-2</td>
<td>1.5</td>
<td>B-1</td>
</tr>
<tr>
<td>60 HP &amp; Over</td>
<td>S-2</td>
<td>3.5</td>
<td>B-2</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>1.5</td>
<td>B-1</td>
</tr>
<tr>
<td><strong>AXIAL FLOWFANS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Floor Mtd.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>S-1/S-2</td>
<td>1.5</td>
<td>B-1</td>
<td>S-1</td>
<td>0.75</td>
<td>S-1</td>
<td>0.75</td>
<td>NA</td>
</tr>
<tr>
<td>20 HP &amp; Over</td>
<td>S-2</td>
<td>3.5</td>
<td>B-2</td>
<td>S-1</td>
<td>1.5</td>
<td>B-2</td>
<td>1.5</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Suspended</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>H-1</td>
<td>1.75</td>
<td>B-1</td>
<td>H-2</td>
<td>1.0</td>
<td>B-1</td>
<td>1.0</td>
<td>NA</td>
</tr>
<tr>
<td>20 HP &amp; Over</td>
<td>H-1</td>
<td>2.5</td>
<td>B-1</td>
<td>H-1</td>
<td>1.75</td>
<td>B-1</td>
<td>1.5</td>
<td>NA</td>
</tr>
<tr>
<td><strong>UTILITY FAN SETS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Floor Mounted</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S - 2/S-1</td>
<td>1.5</td>
<td>B-1</td>
<td>S-1</td>
<td>0.75</td>
<td>B-1</td>
<td>S-1</td>
<td>0.75</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Suspended</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CABINET FANS and FAN SECTIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Floor Mounted</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-1(1)</td>
<td>1.5</td>
<td>NA</td>
<td>S-1</td>
<td>0.75</td>
<td>NA</td>
<td>S-1</td>
<td>0.75</td>
<td>NA</td>
</tr>
<tr>
<td>20 HP &amp; Over</td>
<td>S-2(1)</td>
<td>2.5</td>
<td>B-2</td>
<td>S-1</td>
<td>1.5</td>
<td>NA</td>
<td>S-1</td>
<td>0.75</td>
</tr>
<tr>
<td><strong>Suspended</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 15 HP</td>
<td>H-1</td>
<td>1.75</td>
<td>NA</td>
<td>H-2</td>
<td>1.0</td>
<td>NA</td>
<td>H-2</td>
<td>0.75</td>
</tr>
<tr>
<td>20 HP &amp; Over</td>
<td>H-1</td>
<td>2.5</td>
<td>B-1</td>
<td>H-1</td>
<td>1.75</td>
<td>NA</td>
<td>H-2</td>
<td>1.75</td>
</tr>
</tbody>
</table>

**Notes:**
1. Provided by equipment manufacturer factory installed.
2. Provide full perimeter steel welded frame below equipment
3. Provide support per manufacturer’s recommendation
4. Where internally isolated, hard pipe and duct connections to fan are allowed. If not internally isolated, provide F-2 pipe and F-3 duct connectors.

**D. Pumps – Equipment Isolation**

**TABLE 1: EQUIPMENT ISOLATION SCHEDULE - PUMPS**

<table>
<thead>
<tr>
<th></th>
<th>LOCATION</th>
<th>A' CRITICAL LOCATION (35' - 50' SPAN)</th>
<th>B' UPPER STORY LOCATION (20' - 35' SPAN)</th>
<th>C' BASE LOCATION ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EQUIPMENT</strong></td>
<td></td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>MINIMUM DEFLECTION (IN)</td>
</tr>
<tr>
<td><strong>ISOLATOR TYPE</strong></td>
<td></td>
<td>BASE TYPE</td>
<td>ISOLATOR TYPE</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td><strong>PUMPS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Mtd. type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 5 HP</td>
<td>S-2/S-1</td>
<td>0.75</td>
<td>B-2</td>
<td>S-2/S-1</td>
</tr>
<tr>
<td>7- ½ HP &amp; Over</td>
<td>S-2/S-1</td>
<td>1.5</td>
<td>B-2</td>
<td>S-2/S-1</td>
</tr>
</tbody>
</table>
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPI NG, DUCTWORK, AND EQUIPMENT

<table>
<thead>
<tr>
<th>Vertical Inline floor mounted</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5 HP</td>
<td>P-1 0.15 NA</td>
<td>P-1 0.15 NA</td>
</tr>
<tr>
<td>7- ½ HP &amp; Over</td>
<td>S–2/S-1 1.5 B-2</td>
<td>S–2/S-1 1.5 B-2</td>
</tr>
<tr>
<td>Suspended Inline</td>
<td>H-1 1.75 NA</td>
<td>H-1 1.75 NA</td>
</tr>
</tbody>
</table>

Notes:
1. Provided by equipment manufacturer factory installed.
2. Provide full perimeter steel welded frame below equipment.
3. Provide support per manufacturer’s recommendation.
4. Provide F-1 flexible connector for all integral horsepower pumps, F-2 connector for fractional horsepower pumps.

E. Cooling Plant/Refrigeration Equipment Isolation

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>A’ CRITICAL (35’ - 50’ SPAN)</th>
<th>B’ UPPER STORY (20’ - 35’ SPAN)</th>
<th>C’ ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQUIPMENT</td>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td>REFRIGERATION UNITS</td>
<td>Scroll type Condensing units and Compressors</td>
<td>S-2 2.5 B-2</td>
<td>S–2/S-1 1.5 B-1</td>
</tr>
</tbody>
</table>

Notes:
1. Provided by equipment manufacturer factory installed.
2. Provide full perimeter steel welded frame below equipment.
3. Provide support per manufacturer’s recommendation.
4. Provide F-2 pipe connections to unit.

F. Miscellaneous Equipment Isolation

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>A’ CRITICAL (35’ - 50’ SPAN)</th>
<th>B’ UPPER STORY (20’ - 35’ SPAN)</th>
<th>C’ ON GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQUIPMENT</td>
<td>ISOLATOR TYPE</td>
<td>MINIMUM DEFLECTION (IN)</td>
<td>BASE TYPE</td>
</tr>
<tr>
<td>ROOFTOP AIR CONDITIONING UNITS</td>
<td>Up to 20 Ton</td>
<td>S-2 1.5 C-1</td>
<td>S-2 0.75 C-1</td>
</tr>
<tr>
<td></td>
<td>Over 20 Ton</td>
<td>S-2 2.5 C-2</td>
<td>S-2 1.5 C-2</td>
</tr>
</tbody>
</table>
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

<table>
<thead>
<tr>
<th>ENGINE DRIVEN GENERATORS</th>
<th>S-2</th>
<th>2.5</th>
<th>B-2</th>
<th>S-2</th>
<th>1.5</th>
<th>B-2</th>
<th>S-2</th>
<th>0.75</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 60 HP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 HP &amp; Over</td>
<td>S-2</td>
<td>3.5</td>
<td>B-2</td>
<td>S-2</td>
<td>2.5</td>
<td>B-2</td>
<td>S-2</td>
<td>0.75</td>
<td>NA</td>
</tr>
</tbody>
</table>

Notes:
1. Provided by equipment manufacturer factory installed.
2. Provide full perimeter steel welded frame below equipment.
3. Provide support per manufacturer’s recommendation.
4. Where internally isolated, hard pipe and duct connections to unit are allowed. If not internally isolated, provide F-2 pipe and F-3 duct connectors.

3.2 EXAMINATION
A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 APPLICATIONS
A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service or agency acceptable to authorities having jurisdiction. Indicate on Drawings, by details, schedules, or a combination of both, the locations where hanger rods for individual pipes and hanger rods for trapeze hangers require hanger rod stiffeners.
B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION
A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units except as otherwise indicated. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.
C. Comply with manufacturer's instructions for installation and load application to vibration control materials and units except as otherwise indicated. Adjust to ensure that units have equal deflection, do not bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices intended for temporary support during installation.
D. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
E. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.
F. Flexible Pipe Connectors: Install on equipment side of shutoff valves.
G. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.
VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR PIPING, DUCTWORK, AND EQUIPMENT

H. Equipment Restraints:
1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction. Provide required submittals for components.

I. Piping Restraints:
1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m), and longitudinal supports a maximum of 80 feet (24 m).
3. Brace a change of direction longer than 12 feet (3.7 m).

J. Install cables so they do not bend across edges of adjacent equipment or building structure.

K. Install seismic-restraint devices using methods approved by an evaluation service or agency acceptable to the authorities having jurisdiction, providing required submittals for component.

L. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolts and mounting hole in concrete base.

M. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

N. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

O. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust air-spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 WORK RELATED IN OTHER SECTIONS
A. Section 230500: Basic Materials and Methods
B. Section 230900: Controls and Instrumentation
C. Section 233113: Air Distribution
D. Division 26: Electrical.

1.3 SUMMARY
A. Scope: Extent of testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section, and Section 230500 - Basic Mechanical Requirements.

B. Systems: Testing, adjusting and balancing specified in this Section shall include, but not be limited to, the following systems:
   1. Air handling systems including supply, return and exhaust.
   2. Hydronic system including heating, chilled water and condenser water.
   3. Air distribution ductwork including supply, return and exhaust.
   4. Smoke control system.
   5. Automatic temperature control system.
   6. General exhaust systems.
   7. Domestic hot water recirculation piping.
   8. Underfloor air distribution system air leakage.
   9. Instruction of Owner's personnel for future balancing of systems.

C. Reference Standards
   4. AABC-National Standards for Total System Balance.
   5. NEBB-Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
   9. American National Standards Institute (ANSI): Comply with the following:
      a. S1.4Specification For Sound Level Meters.
      b. S1.11Specification For Octave-Band and Fractional-Octave-Band Analog and Digital Filters
   10. Chapter 4 of applicable Mechanical Code.

1.4 QUALITY ASSURANCE
A. Contractor's Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 5 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, who is not
the installer of the system to be tested and is otherwise independent of the project. **Testing, adjusting, and balancing shall be performed by a certified NEBB technician or a certified AABC technician under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor.** Testing and balancing agency must submit qualifications for review and approval prior to acceptance for work.

B. **Penalty:** The Contractor shall submit the name of the organization he proposes to employ for approval within 30 days after contract award. If the Contractor fails to submit the name of an acceptable agency within the specified time, a firm may be selected to accomplish the work, and this selection shall be binding upon the Contractor at no additional cost.

C. **Retainages:** In addition to any other sums retained or withheld pursuant to the provisions of this Contract, the amount of dollars will be withheld from payments to the contractor until such time as the work has been completed and accepted. In no event will this amount be paid to the Contractor prior to 60 days following acceptance of the project; during such time, the Contractor shall investigate and correct any reported deficiencies unless such deficiencies are a result of unauthorized tampering by building occupants.

D. **Calibration of Testing Instruments:** All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over 6 months.

E. Testing and balancing agency, as part of its contract, shall act as authorized inspection agency responsible to Consulting Engineer and Owner, and shall list all items that are installed incorrectly, require correction, or have not been installed in accordance with contract Drawings and Specifications, pertaining to air distribution, cooling and heating systems. The testing and balancing agency is required to provide written reports of all deficiencies and proposed recommendations to the Owner Representative, Contractor, Architect and Engineer.

F. The testing and balancing agency shall provide with his bid a performance guarantee covering all phases of the work as herein specified.

G. The General and Mechanical Contractors shall cooperate with the selected testing and balancing agency in the following manner:
   1. Provide sufficient time before final completion dates so that tests and balancing can be accomplished.
   2. The various system installers, suppliers and contractors shall provide all required materials, labor and tools to make corrections when required without undue delay. Install balancing dampers as required by testing and balancing agency.
   3. The contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of the same during each working day of testing and balancing.
   4. Testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with a complete set of Record Drawings.
   5. The General Contractor shall make space and other facilities available to the testing and balancing agency to enable their work to progress. The General Contractor shall schedule the work of other trades to avoid conflicts with this work.

### 1.5 SUBMITTALS

A. **Conform to the Submittals requirements of Division 01.**

B. **Forms:** The Contractor shall deliver a complete copy of either NEBB or AABC standard forms for testing and balancing work associated with the project. These forms shall serve as specific guidelines for producing final test report. Hybrid or non-standards forms are not acceptable. Data shall include, but not be limited to, a title page with building information, instrument lists, air flows, water flows, temperatures, sound levels, capacities, nameplate data.
C. Test Reports: Provide six (6) certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include identification and types of instruments used, and their most recent calibration date, and key plans identifying all inlets and outlets. Final test reports shall be typed. Hand written reports are not acceptable.

D. Maintenance Data: Include, in maintenance manuals, copies of certified test reports and identification of instruments.

E. Qualifications: The Contractor shall submit the certified individual qualifications of all persons responsible for supervising and performing the actual work and the name of the certifying engineer. Provide a reference list of five (5) similar size projects with contact person and telephone number.

1.6 AGENDA

A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.
   1. Review plans and specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.
   2. The agenda shall include a general description of each air and water system with its associated equipment and operation cycles for heating and cooling.
   3. The agenda shall include a list of all air and water flows to be performed at all mechanical equipment.
   4. The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas such as conference rooms.
   5. The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts, sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.
   6. Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch) and factors for:
      a. Air terminal configuration.
      b. Flow direction (supply or exhaust).
      c. Velocity corrections.
      d. Effective area applicable to each size and type of air terminal.
      e. Density corrections.
   7. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date.

1.7 JOB CONDITIONS

A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.
   1. Work has been completed and is operable. Ensure that there is no latent residual work yet to be completed on the tested equipment.
   2. Work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.
   3. All architectural openings (doors, windows, and other openings) which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal states.
   4. All related mechanical systems which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal operating conditions.
PART 2 - PRODUCTS

2.1 TEST HOLES
A. Test holes shall be provided in ducts, housings and pipes as necessary for the proper air and water measurements and to balance systems. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.

2.2 PATCHING MATERIALS
A. Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.
   1. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.
   2. Piping shall be capped with materials the same as the piping system.
   3. Insulation shall be neatly hemmed with metal or plastic edging, leaving test points visible for future testing.

2.3 TEST INSTRUMENTS
A. Standards: Utilize instruments and equipment of type, precision, and capacity as recommended in the NEBB "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and AABC manual MN-1.
B. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. A representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.
C. Additional Instruments: Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against transfer standard instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.
D. Cone Instruments: The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser/grille/register air flow measurements. The readout meters shall meet calibration requirements.

PART 3 - EXECUTION

3.1 PROCEDURES AND INSTRUMENTS, GENERAL
A. Requirements: All systems and components thereof shall be adjusted to perform as required by drawings and specifications.
B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.
C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.
   1. All instruments shall be applied in accordance with the manufacturer's certified instructions.
   2. All labor, instruments, and appliances required shall be furnished by the Contractor. Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation.

3.2 DUCT SMOKE DETECTORS
A. The testing and balancing agency shall direct the placement of all duct mounted smoke detectors.
   1. Obtain information from the Contractor who is to furnish the smoke detectors on the proper device placement and installation limitations and on the proper differential pressure across the sampling tubes of the duct detectors.
TESTING, ADJUSTING AND BALANCING

2. Based on the submitted manufacturer's installation guidelines indicate the proper mounting location to the installing Contractor.

B. After the installation of all smoke detectors test them again in the final installation position and report differential pressures.

3.3 AIR SYSTEM PROCEDURES

A. Adjustments: Adjust all air handling systems to provide approximate design air quantity to or through, each component, and to maintain stable and comfortable interior temperatures, free of drafts or stagnant conditions. Adjusting and balancing of all systems shall be conducted during periods of the year approximating maximum seasonal operation.

B. Equalizers: Equalizing devices shall be adjusted to provide uniform velocity across the inlets (duct side for supply) of terminals prior to measuring flow rates.

C. Balance: Flow adjusting (volume control) devices shall be used to balance air quantities (i.e., proportion flow between various terminals comprising system) to the extent that their adjustments do not create objectionable air motion or sound (i.e., in excess of specified limits).
   1. Balancing between runs (submains, branch mains, and branches) generally shall be accomplished by flow regulating devices at, or in, the divided-flow fitting.
   2. Restriction imposed by flow regulating devices in or at terminals shall be minimal.
   3. Final measurements of air quality shall be made after the air terminal has been adjusted to provide the optimum air patterns of diffusion.

D. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds or axial-flow fan wheel blade pitch. Damper restriction of a system's total flow may be used only for systems with direct-connected fans (without adjustable pitch blades), provided system pressure is less than 1/2-inch W.G. and sound level criteria is met.

E. Air Measurement: Where air quantity measuring devices are specified in other sections such systems shall be used as a cross-check of portable measuring equipment.
   1. Except as specifically indicated herein, pitot tube traverses shall be made of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE "Handbook Fundamentals Inch Pound Edition."
   2. For ducts serving modular office areas with movable partitions, which are subject to change, pitot tube traverses may be omitted provided the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of pitot tube traverses, airflow in the duct shall be determined by totaling volume of individual terminals served, measured as described herein.
   3. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.

F. Test Holes: Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.

G. Air Terminal Balancing: Generally, measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for the balancing agenda. Laboratory tests shall be conducted to prove of methodology when so directed. Such tests shall be conducted in conformance with applicable ASHRAE or American Society of Mechanical Engineers (ASME) codes and shall be made at no cost.

H. Air Motion: Air motion and distribution shall be as specified and indicated on drawings. The Contractor at no additional cost shall, in addition to air motion measurements, make smoke tests wherever requested to demonstrate the air distribution from air terminals.

I. Air system test and balance procedures shall include, but not be limited to the following requirements:
TESTING, ADJUSTING AND BALANCING

1. Test and adjust blower RPM to design requirements.
2. Test and record motor full load amperes.
3. Make pitot tube traverse of main supply ducts and obtain design CFM at fans.
4. Test and record system pressures, suction and discharge.
5. Test and adjust system for design recirculated air, CFM.
6. Test and adjust system for design CFM outside air.
7. Test and record entering air temperatures.
8. Test and record leaving air temperatures.
9. Adjust all supply, return and exhaust air ducts to proper design CFM.
10. Adjust all zones to proper design CFM, supply and return.
11. Test and adjust duct systems and each diffuser, grille, and/or register to within 10% of design requirements.
12. Each grille, diffuser and register shall be identified as to location and area.
13. Size, type and manufacturer of VAV boxes, diffusers, grilles, registers and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.
14. Readings and tests of diffusers, grilles and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustment.
15. In cooperation with the control manufacturer's representative, setting adjustments of automatically operated dampers to operate as specified, indicated, and/or noted. Testing agency shall check all controls requiring adjustment by control installers. Room thermostats shall be checked for cooling and heating response.
16. All diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.
17. Adjust overall system balances to allow all self-closing exterior doors to close from any open position. Maximum interior air pressure in all operational modes shall not exceed 0.05" static pressure relative to the outside air pressure. Comply with chapter 10 of the Building Code to assure that self-closing doors with release with a maximum force of 15 lbs.
18. As part of the work of this contract, the HVAC contractor shall make any changes in the pulleys, belts and dampers or the addition of dampers required for correct balance as recommended by air balance agency, at no additional cost to Owner.
19. After air balancing is completed and RPM determined, HVAC Contractor shall provide fixed pitch pulleys.
20. All mixing boxes, VAV air valves, control dampers, smoke dampers and similar devices which operate at 100% shut off shall be tested for leakage.
21. Variable Air Volume Fan Systems: The primary balancing mode is 100% outside air with all terminal boxes on a full call for cooling. Also check and record performance at minimum outside air with all terminal boxes on call for full cooling and at minimum outside air with all terminal boxes on call for full heating. Verify that the systems are operating on a stable part of the fan curves in each mode. Record final duct static controller settings.
22. Editor-remove the following if no UFAD.
23. Provide testing of underfloor air distribution plenum floor mock-ups and final floor installation to document that plenum does not exceed 5% air leakage rate at maximum 0.10" w.g. positive differential pressure. Editor-remove the following if no stairwells.
24. Stairwell pressurization balancing including doors and vestibule differential pressures and forces as required by the local ordinances and fire marshal.
25. Smoke control systems per chapter 9 of the Building Code and as required by the local ordinances and fire marshal.

3.4 AIR SYSTEM DATA

A. Report: The certified report shall include for each air handling system the data listed below.

1. Equipment (Fan or Factory Fabricated Station Unit):
   a. Installation data
      1) Manufacturer and model
      2) Size

SERA Architects Inc. Package 4 - 50% Construction Documents
TESTING, ADJUSTING AND BALANCING

3) Arrangement, discharge and class
4) Motor hp, voltage, phase, cycles, and full load amps
5) Location and local identification data

b. Design data
1) Data listed in schedules on drawings and specifications.
c. Fan recorded (test) data
1) cfm
2) static pressure
3) rpm
4) motor operating amps
5) motor operating bhp

2. Duct Systems:
   a. Duct air quantities (maximum and minimum) - main, submains, branches, outdoor (outside) air, total air, and exhaust:
      1) duct size(s)
      2) number of pitot tube (pressure measurements)
      3) sum of velocity measurements (Note: Do not add pressure measurements)
      4) average velocity
      5) recorded (test) cfm
      6) design cfm
   b. Individual air terminals
      1) terminal identification supply or exhaust, location and number designation
      2) type size, manufacturer and catalog identification applicable factor for application, velocity, area, etc., and designated area
      3) design and recorded velocities - fpm (state "core," "inlet," etc., as applicable)
      4) design and recorded quantities - cfm (deflector vane or diffusion cone settings)

3.5 DUCTWORK AIR LEAKAGE TESTING

A. Test and balance agency shall perform active air flow testing of ductwork systems or sections of ductworks. Agency shall inspect and confirm that all ductwork is sealed per the specification requirements prior to performing any testing. Calculate maximum allowable air leakage by system based on total design air flow rate. Maximum allowable system leakage shall not exceed 5%. Test a random sample of 10% of the ductwork. If any ductwork within the sample fails to meet the criteria than an additional 10% (20% total) sample must be measured. If any ductwork within this second 10% sample fails than 100% of all ductwork must be tested and verified to have a leakage rate than does not exceed the maximum allowable limit.

B. Ductwork systems to be leakage tested shall include:
   1. Testing shall be performed at 1.5 times the peak design outlet static pressure from the air handling unit/fan, but not greater than the maximum SMACNA pressure rating of the ductwork construction classification. Testing is not required of flexible ductwork or ductwork downstream of VAV terminal units.
   2. Leakage through manufactured products, such as dampers, fire smoke dampers and terminal units may be excluded from the leakage calculations based on manufacturer stated values, at pressure, or these units may be temporarily sealed with painter's tape during testing to seal any openings and must be removed after testing.
   3. Supply air ductwork from outlet of the air handling unit/fan to inlet side of terminal units or connection to flexible ductwork.
   4. All supply, return and exhaust air ductwork located outside the building envelope.
   5. Return and exhaust air ductwork located in unconditioned spaces from inlet of the air handling unit/fan to the ductwork terminations upstream of each return air grille.
   6. Laboratory and fume hood exhaust air ductwork from inlet of the air handling unit/fan to the connection at the remote exhaust air grille or fume hood connection.
   7. Kitchen exhaust air ductwork from inlet of the exhaust fan to the connection at the remote exhaust hood.
C. Ductwork installer shall prepare ductwork for pressure testing as deemed appropriate to maintain construction schedule. Ductwork may be tested as total systems or in sections. Sectional testing will require documentation to prove the totalized system leakage is within allowable range of entire system. Ductwork inlets and outlets may be temporarily sealed airtight with plastic, or other means, to facilitate testing pressures.

D. Testing may occur through ductwork devices such as balancing dampers, smoke fire dampers and coils. Manufacturer provided air leakage allowances for such devices may be excluded from duct leakage measurement but must be documented in final report.

E. Perform all testing utilizing a duct leakage testing system, Oriflow Duct Leakage Tester or equal, with calibrated fan, orifice, gauges, ductwork, pressure tips and tubing.

3.6 UNDERFLOOR PLENUM AIR LEAKAGE TESTING

A. Test and balance agency shall perform active air leakage testing of raised floor plenums. Agency shall inspect and confirm that all plenums are sealed per the specification requirements prior to testing. Agency shall coordinate with commissioning agent and all installing contractors and identify areas where floor plenum integrity has been compromised. Reports of inspections will be submitted to the general contractor.

B. Plenum Mock-Up & Testing: All subcontractors responsible for constructing or penetrating the underfloor plenum must participate in the construction of an on-site plenum mockup consisting of all planned plenum components, penetrations, seams and openings. The mock-up plenum is to be inspected and tested by the test and balance agency and an independent commissioning agent for air leakage to verify that it was constructed and sealed in accordance with specifications and drawings including meeting the air leakage requirements.

C. Air leakage requirement for mock-up and final plenums: total air leakage from each plenum should be no more than 5% of the design airflow when tested at a static pressure of 0.10” w.g. (25 Pascals). Areas with leakage exceeding 5% shall be inspected, repaired and retested until such time that plenum leakage is less than 5% of the design air flow for each floor area.

D. Perform all pressure testing using a calibrated blower door apparatus, such as a Minneapolis Blower Door model 3 as manufactured by the Energy Conservatory. The fan discharge plenum shall be sized to match a typical floor tile, such as 24” x 24”. A minimum of three measurements shall be obtained to assure the average pressure does not exceed the allowable leakage rate. Document results in TAB report.

3.7 WATER SYSTEM PROCEDURES

A. Preparation:
   1. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.
   2. Remove all strainers and clean same. Reinstall.
   3. Examine water system and determine if water has been treated and cleaned.
   4. Check pump rotation.
   5. Check expansion tank to determine they are not air bound and the system is completely full of water.
   6. Check all air vents at high points of water systems and determine that all are installed and operating freely.
   7. Check operation of automatic bypass valve.
   8. Check and set operating temperatures of all equipment at design requirements.
   9. Complete air balance must have been accomplished before actual water balance begins.

B. Adjustment: All heating, cooling and condensing water systems shall be adjusted to provide required quantity to or through each component.

C. Metering: Water quantities and pressures shall be measured with calibrated meters.
   1. Venturi tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems. Systems shall be adjusted to provide the...
TESTING, ADJUSTING AND BALANCING

approved pressure drops through the heat transfer equipment (coils except room units, converters, etc.) prior to the capacity testing.

2. Where flow metering fittings are not installed, in air/water type heat transfer equipment, flow balance shall be determined by measuring the air side energy differential across the heat transfer equipment. Measurement of water temperature differential shall be performed with the air system, adjusted as described herein, in operation.

D. Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.

E. Flow: Flow through bypass circuits at three-way valves shall be adjusted to equal that through the supply circuit, when the valve is in the bypass position.

F. Distribution: Adjustment of distribution shall be effected by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided; service valves shall not be used.

1. Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.

G. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

H. Water System Test and Balance Procedure: Perform the following tests, and balance each system in accordance with the following requirements:

1. Set chilled, heating and condenser water pumps to proper gallons per minute delivery.
2. Adjust chilled water flow through chiller(s).
3. Adjust heating water flow through boiler(s).
4. Adjust condenser water flow through cooling tower(s).
5. Test and record entering and leaving water temperatures through chillers, boilers and cooling towers.
6. Test and record water temperatures at inlet and outlet side of each terminal unit. Note rise or drop of temperatures from source.
7. Proceed to balance each terminal unit.
8. Upon completion of flow readings and adjustments at coils, mark all settings and record data.
9. After adjustments to coils are made, recheck settings at the pumps, chiller, boilers, and cooling towers and readjust if required.
10. Record and check the following items at each coil.
   a. Inlet water temperatures.
   b. Leaving water temperatures.
   c. Water pressure drop of each coil.
11. Pump operating suction and discharge pressures and final total dynamic head.
12. List all mechanical specifications of pumps.
13. Rated and actual running amperage of pump motor.

3.8 WATER SYSTEM DATA

A. Report: The certified report for each water system shall include the data listed below.

1. Pumps:
   a. Installation data
      1) manufacturer and model
      2) size
      3) type drive
      4) motor hp, voltage, phase, and full load amps
TESTING, ADJUSTING AND BALANCING

b. Design data
   1) gpm
   2) head
   3) rpm and amps

c. Recorded data
   1) discharge pressures (full-flow and no-flow)
   2) suction pressures (full-flow and no-flow) operating head
   3) operating gpm (from pump curves if metering is not provided) no-load
   4) amps
   5) full-flow amps
   6) no-flow amps

2. Air Heating and Cooling Equipment:
   a. Design data
      1) load in Btu or MBh
      2) gpm
      3) entering and leaving water temperature
      4) entering and leaving air conditions (DB and WB)
      5) cfm
      6) water pressure drop
      7) entering steam pressure
   b. Recorded data
      1) type of equipment and identification (location or number designation)
      2) entering and leaving air conditions (DB and WB)
      3) entering and leaving water temperatures
      4) gpm (if metered)
      5) temperature rise or drop
      6) entering steam pressure

3. Water Chilling Units:
   a. Installation data
      1) manufacturer and model
      2) motor hp, voltage, cycles, phase, and full load amps
      3) part load amperes
      4) gpm - chiller and condenser
      5) water pressure drop - chiller and condenser
      6) entering and leaving water temperature - chiller and condenser
   b. Recorded data (chiller and condenser)
      1) gpm
      2) water pressure drop
      3) entering and leaving water temperature
      4) amperes

4. Heat Exchangers:
   a. Installation Data
      1) manufacturer, model, and type
      2) flow rate
      3) inlet (entering) and outlet (leaving) temperatures
      4) inlet (entering) and outlet (leaving) pressures
   b. Recorded Data
      1) flow rate
      2) entering and leaving water temperatures
      3) entering and leaving pressures

3.9 HEAT EXCHANGER CAPACITY VERIFICATION
   A. Air coil capacities shall be verified from air side measurement data. Capacities of coils shall be the difference of the energy carried by the air between the up stream and down stream of the coils.
TESTING, ADJUSTING AND BALANCING

B. The measured air flow rate for the fan may be used for air coil capacity calculations providing no ducted bypassing of coil is occurring.

C. Water/water heat exchanger equipment capacity shall be verified by measuring the flow rate and temperature differential of the water.

D. Capacity verification shall be performed after air and water systems have been balanced.

E. False load shall be applied if the upstream air or water does not meet the specified conditions at the time of test.

3.10 SOUND TEST PROCEDURES

A. Scope: Tests of sound levels shall be made at each selection point included in the agenda.

B. Timing: Sound level measurements shall be taken at times when the building is unoccupied, or when activity in surrounding areas and background noise level in areas tested are at a minimum and relatively free from sudden changes in noise levels.
   1. Measurements shall be taken with all equipment turned off, except that being tested.
   2. The required sound levels shall be measured at any point within a room not less than 6 feet from an air terminal or room unit, and not closer than 3 feet from any floor, wall, or ceiling surface.

C. Meters: Sound levels shall be measured with a sound meter complying with ANSI S1.4. The "A" scale shall be used to measure over all sound levels. To determine the specified octave band levels, the above sound level meter, set on "C" scale, shall be supplemented by an octave band analyzer complying with ANSI S1.11.

D. Equipment Components: The "Equipment Component" of room sound equals LPt-C. The "Equipment Component" of room sound (noise) levels shall be determined for each of eight octave bands as follows:
   1. Measure room sound pressure level "LPb" with equipment to be tested shut off.
   2. Measure room sound pressure level "LPt" with equipment to be tested turned on.
   3. Calculate LPt-LPb; if this value is less than 1, applicable test must be rerun with lower background level (LPb) unless LPt is within sound pressure level specified for equipment.
   4. Determine "c" from the table below.

<table>
<thead>
<tr>
<th>LPt-LPb (db)</th>
<th>c (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4 to 4-½</td>
<td>2</td>
</tr>
<tr>
<td>5 to 5-½</td>
<td>1 – ½</td>
</tr>
<tr>
<td>6 to 7-½</td>
<td>1</td>
</tr>
<tr>
<td>8 to 12</td>
<td>½</td>
</tr>
<tr>
<td>over 12</td>
<td>0</td>
</tr>
</tbody>
</table>

3.11 SOUND LEVEL DATA

A. Report: certified report shall record data on sound levels, taken at each selected location, as follows:
   1. Source of sound and location.
   2. Diagram or description of relationship of sound source to measuring instrument.
   3. "A" scale readings equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
   4. Readings at each specified octave band frequency equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).
   5. "Equipment Components" of sound (noise) levels with applicable calculations per "Sound Test Procedures".
   6. Graph showing relationship between pressure levels specified and recorded readings.
TESTING, ADJUSTING AND BALANCING

B. Retest: Subsequent to any correctional construction work, such as acoustic corrections, measurement shall be made to verify that associated air and water quantities, as previously measured, have not been disrupted.

1. Certified report shall record all sound data, and their locations, after final adjustments of air and water systems involves.

3.12 CERTIFIED REPORTS

A. Submittals: Six (6) copies of the reports described herein, covering air and water system performance, air motion (fpm), and sound pressure levels, shall be submitted prior to final tests and inspection.

B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.

C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and design deficiencies.

D. Certification: Certification shall include checking of adherence to agenda, of calculations, of procedures, and evaluation of final summaries.

3.13 FINAL COMMISSIONING TESTS, INSPECTIONS AND ACCEPTANCE

A. Scope: Test shall be made to demonstrate that capacities and performance of air and water systems comply with contract requirements.

1. At the time of final inspection, the Contractor shall recheck, random selection of data (water and air quantities, air motion, and sound levels) recorded in the certified report. In addition, all courtrooms, auditoriums, and conference rooms shall be rechecked.

2. Points and areas for recheck shall be selected by the commissioning team.

3. Measurement and test procedures shall be the same as approved for work forming basis of certified report.

4. Selections for recheck (specific plus random), in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, or a sound level of 2 db or more greater than, that recorded in the certified report listings, as 10 percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost. Retainage time shall be based on the date of the final acceptance of the certified report.

C. Marking of Settings: Following final acceptance of certified reports, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:

1. Ductwork Insulation:
   a. Duct wrap insulation.
   b. Acoustic duct lining.
   c. Rigid board ductwork and plenum insulation.
   d. Fire Rated duct insulation systems.
   e. Field applied jackets, indoor and outdoor.

2. Section Includes insulating the following duct services:
   a. All supply air ductwork, unless otherwise shown on drawings.
   b. All return air ductwork, unless otherwise shown on drawings.
   c. Acoustical duct lining, in vertical/horizontal supply and return ducts within twenty feet (20’) of air handling equipment and where otherwise shown on drawings.
   d. Outside air ductwork in return plenums, mechanical rooms and in freezing climates
   e. Exhaust air ductwork in cold air plenums.
   f. Vapor/moisture ductwork.
   g. Insulation to protect fire rated exhaust systems

3. Piping Insulation:
   a. Piping insulation.
   b. Insulation Jackets
   c. Removable Covers.

4. Section includes the following HVAC piping systems:
   a. Heating hot water supply and return piping.
   b. Chilled water supply and return piping.
   c. Steam and condensate return piping.
   d. Valves, pumps, air separators, strainers and fittings in insulated piping systems.
   e. Refrigerant hot gas and suction piping.

5. HVAC equipment insulation - section includes the following HVAC equipment that is not factory insulated:
   a. Heat exchangers.
   b. Converters.
   c. Chilled-water pumps.
   d. Heating, hot-water pumps.
   e. Steam condensate pumps.
   f. Expansion/compression tanks.
   g. Air separators.
   h. Steam condensate tanks.
   i. Steam flash tanks, flash separators, moisture separators, and blow-off tanks.

6. Plenums and equipment rooms, as noted.

B. Types of mechanical insulation specified in this Section include the following:

1. Duct wrap insulation: Fiberglass.
2. Duct wrap insulation: Radiant bubble duct wrap.
3. Duct wrap insulation: Flexible elastomeric foam.
5. Acoustic duct liner: Natural fiber.
HVAC INSULATION

8. Rigid board duct and plenum insulation: Calcium silicate.
10. Fire-rated duct insulation: Calcium silicate.
15. Pipe insulation: Closed cell phenolic.
17. Pipe insulation: Calcium silicate.
21. Equipment insulation: Calcium silicate.
22. Equipment insulation: Cellular glass.
23. Equipment insulation: Flexible elastomeric closed cell foam.
24. Insulation jackets.
25. Removable covers
26. Insulation accessories.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 220501: Plumbing.
B. Section 230500: Basic Materials and Methods.
C. Section 232113: HVAC Piping, Valves and Specialties.

1.4 DEFINITIONS
A. Ambient: The air temperature to be maintained in a conditioned room. Typically between 70°F and 78°F.
B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.
C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.
D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.
E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.
F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.
G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.
H. Freezing Climate: Where outdoor design temperature is less than 33°F, as stated in ASHRAE fundamentals under 99% column for winter design conditions.
I. Unconditioned Space: any space whose airstream is not directly conditioned by mechanical equipment or maintained to temperature by mechanical equipment.

1.5 QUALITY ASSURANCE
A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:
HVAC INSULATION

b. C165 - Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
c. C167 - Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
g. C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
i. C303 - Test Method for Density of Preformed Block-Type Thermal Insulation.
j. C305 - Test for Thermal Conductivity of Pipe Insulation.
k. C356 - Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
l. C411 - Test for Hot-Surface Performance of High Temperature Thermal Insulation.
q. C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
s. C552 - Specification for Cellular Glass Block and Pipe Thermal Insulation.
t. C553 - Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
u. C592 - Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:
   a. 90 Energy Conservation in New Building Design.

   Manufacture insulation in accordance with the following NFPA standards:
   a. 255 Test Methods, Surface Burning Characteristics of Building Materials.
HVAC INSULATION

B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

C. Products Containing Prohibited Chemicals:
   1. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass:
      a. Pentabrominated diphenyl ether (CAS#32534-81-9)
      b. Octabrominated diphenyl ether (CAS#32536-52-0)
      c. Decabrominated diphenyl ether (CAS#1163-19-50)

D. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

E. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.
   1. Test Specimen: Two specimens shall be used, each measuring 1" by 4" by approximately ½" thick.
   2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1" wide, 4" long and 0.020" thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lb/sq. ft.
   3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.

F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory. Submit samples.

B. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:
   1. Pentabrominated diphenyl ether (CAS#32534-81-9)
   2. Octabrominated diphenyl ether (CAS#32536-52-0)
   3. Decabrominated diphenyl ether (CAS#1163-19-50)

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.
HVAC INSULATION

B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Johns Manville, Owens-Corning, Knauf, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabc o, Reflectix, or approved equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.2 DUCT WRAP INSULATION:

A. Type DW-A. Flexible Fiberglass Blanket: Johns Manville Microlite XG, formaldehyde-free Type 75 Flexible Blanket, Knauf ECOSE Duct Wrap:
   1. Application: Insulation wrap for ductwork, or other HVAC systems.
   2. 'K' Value: ASTM C553-92, 0.27 Btu•in./(hr•ft²•ºF) at 75°F installed full thickness.
   3. Density: 0.75 lb/cu ft.
   4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft.
   5. Installation: See Part 3 below.

B. Type DW-B. Radiant Bubble Wrap: Radiant Guard, Reflectix or approved equal:
   1. Application: Insulation wrap for ductwork, or other HVAC systems in general or ISO rated clean environments
   2. Two layers of 5/32” barrier bubble film laminated between two layers of foil. Nylon reinforced. Installation of spacers between layers to create air space is required.
   3. Flame spread – less than 25 ASTM 84 Smoke Development – less than 50 ASTM E84 Fire Rating – Class A/Class 1
   4. R-Value: R-4.2 wrapped without any spacers direct to duct. R-6 using single layer with ¾” spacers and air space between wrap and duct. R-8 using two layers with ¾” spacers between ductwork and each layer of wrap.
   5. Vapor Barrier Tape: Pressure sensitive aluminum foil. 2.0 mil.

C. Type DW-C Elastomeric Foam: Armacell Industries model AP Armaflex and AP Coilflex or equal, Flexible insulation:
   1. Greenguard certified, low VOC.
   2. Elastomeric foam insulation with acrylic polymer airstream coating.
   3. K' Value: ASTM C518, 0.25 Btu•in./(hr•ft²•ºF) at 75°F.
   4. R' value per inch thickness: ASTM C518, 4.0 (hr•ft²•ºF) / Btu at 75°F.
   6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
   8. Noise Reduction Coefficient: ASTM C 423, 0.49 or higher based on “Type A mounting.”
   9. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
   10. Maximum operating temperature: 250 degrees F.
   11. Flame spread index: ASTM E84, less than 25
   12. Smoke developed index: ASTM E84, less than 50

2.3 ACOUSTIC DUCT LINER:

A. Type ADL-A. Fiberglass Acoustic Duct Liner: Johns Manville Duct Liner PM with Anti-Microbial Treatment.
   1. Application: Duct lining for acoustic or thermal purposes.
   2. 'K' Value: ASTM 1071, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
3. Noise Reduction Coefficient: 0.65 or higher based on "Type A mounting."
4. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
5. Adhesive: UL listed waterproof type compliant with ASTM C916.
6. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

B. Type ADL-B Natural Fiber (Cotton) Acoustic Duct Liner: Reflectix #HVNF, Flexible Blanket with Anti-Microbial Treatment:
1. 'K' Value: ASTM C518, 0.25 Btu in./(hr*ft*ºF) at 75°F.
2. Noise Reduction Coefficient: 0.75 or higher based on "Type A mounting."
3. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
5. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

C. Type ADL-C Elastomeric Foam Duct Liner: Armacell Industries model AP Armaflex and AP Coilflex or equal, Flexible insulation:
1. Greenguard certified, low VOC.
2. Elastomeric foam insulation with acrylic polymer airstream coating.
3. K' Value: ASTM C518, 0.25 Btu in./(hr*ft*ºF) at 75°F.
4. R' value per inch thickness: ASTM C518, 4.0 (hr*ft*ºF) / Btu at 75°F.
6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
8. Noise Reduction Coefficient: ASTM C 423, 0.49 or higher based on "Type A mounting."
9. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
10. Maximum operating temperature: 250 degrees F.
11. Flame spread index: ASTM E84, less than 25
12. Smoke developed index: ASTM E84, less than 50
14. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

D. Type ADL-D Polymide Foam Acoustic Duct Liner: Evonic Industries model SOLCOUSTIC, or equal, Flexible Blanket:
1. Greenguard certified, low VOC.
2. Polymide foam insulation with acrylic polymer airstream coating.
3. K' Value: ASTM C518, 0.30 Btu in./(hr*ft*ºF) at 75°F.
4. R' value per inch thickness: ASTM C518, 3.3 (hr*ft*ºF) / Btu at 75°F.
5. Density: ASTM D 3574, 0.80 lb/ft³.
6. Water vapor sorbtion: ASTM C 1104, less than 2% by weight.
8. Noise Reduction Coefficient: ASTM C 423, 0.70 or higher based on "Type A mounting."
9. Maximum Velocity on Mat or Coated Air Side: 5,000 ft/min.
10. Maximum operating temperature: 250 degrees F.
11. Flame spread index: ASTM E84, less than 25
12. Smoke developed index: ASTM E84, less than 50
14. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

E. Type ADL-E Round Duct Liner: Johns Manville with Anti-Microbial Treatment.

F. Spiracoustic Plus
1. Application: Round duct lining for acoustic or thermal purposes.
2. 'K' Value: ASTM C518, 0.23 Btu in./(hr*ft*ºF) at 75°F.
3. Noise Reduction Coefficient: 0.70 as per ASTM C427. (Type A mounting.)
4. Maximum Velocity: 4,000 ft/min.

2.4 RIGID BOARD DUCTWORK AND PLENUM INSULATION:
HVAC INSULATION

A. Type RB – A. Hydrous Calcium Silicate: IIGThermo-12/Gold ASTM C533; Rigid Molded Block Insulation; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
1. "K" Value: 0.40 Btu\(\text{in.} / (\text{hr} \cdot \text{ft}^2 \cdot \circ F)\) at 300°F.
2. Maximum Service Temperature: 1,200°F.
3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½" thickness.
4. Tie Bands: Secure blocks in places with staggered joints using ⅜" or ½" stainless steel bands on 12" centers.

B. Type RB – B Rigid Fiberglass Board: Knauf ECOSE insulation board:
1. Application: insulation for HVAC plenums and ductwork.
2. 'K' Value: ASTM C1071, 0.23 Btu\(\text{in.} / (\text{hr} \cdot \text{ft}^2 \cdot \circ F)\) at 75°F.
3. Density: 3.0 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft paper.
5. Installation: See Part 3 below.

2.5 FIRE-RATED INSULATION SYSTEMS

A. Type FRI-A. Hydrous Calcium Silicate: IIG Thermo-12/Gold ASTM C533; Rigid Molded Block Insulation; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
1. "K" Value: 0.40 Btu\(\text{in.} / (\text{hr} \cdot \text{ft}^2 \cdot \circ F)\) at 300°F.
2. Maximum Service Temperature: 1,200°F.
3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½" thickness.
4. Tie Bands: Secure blocks in places with staggered joints using ⅜" or ½" stainless steel bands on 12" centers.

B. Type FRI-B. Insulation for Type I, commercial, kitchen hood exhaust ductwork. High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.
1. Products:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap 15A.
   f. Unifrax Corporation; FyreWrap.

C. Type FRI-C. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C). Comply with ASTM C 656, Type II, Grade 6. UL tested and certified to provide a [2]-hour fire rating.
1. Products:
   a. Johns Manville;
   b. Super Firetemp M.

D. Type FRI-D. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.
1. Products:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap 15A.
   f. Unifrax Corporation; FyreWrap.
   g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.
HVAC INSULATION

2.6 FIELD APPLIED DUCTWORK INSULATION JACKETS

A. Field Applied Jackets (For Exterior Applications):
1. Longitudinal seams shall not be located on top of ducts when exposed to outdoor environment.
2. Stainless Steel Jacket: Type 304 stainless steel, 0.010” minimum (smooth/corrugated) finish.
3. Aluminum Jacket: 0.016” aluminum with factory applied moisture barrier positioned such that the longitudinal overlap provides a watershed.
4. Circumferential joints shall be wide enough to provide weather-proofing jacket.
5. Secure jacket with ¾” or ½” stainless steel bands on 12” centers for round ductwork and objects.

B. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of ductwork

2.7 PIPE INSULATIONS

A. Glass Fiber: Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
1. Type PI-A: Fiberglass, Non-Wicking:
   a. Manufacturers:
      1) Johns Manville Micro-Lok Meeting ASTM C547; or FSK faced Micro-Flex (pipe sizes larger than 18”)
      2) Knauf
      3) einsulation
   b. Applications: Insulation of piping up to 18” in diameter and 3” thick insulation.
   c. ‘K’ Value: 0.23 at 75°F.
   d. Maximum Service Temperature: 850°F.
   e. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.

B. Type PI-B: Closed cell phenolic foam: Trymer Supercel, Kingspan Koolphen K, Resolco Insul-phen, or approved equal meeting ASTM C 1126.
1. ‘K’ Value: 0.16 at 75°F (24°C)
2. Maximum Continuous Service Temperature: 300°F.
3. Vapor Retarder Jacket – straight sections: Saran 540/SSL or Mylar laminate, factory applied with self sealing lap.

C. Type PI-C: Rigid polyisocyanurate foam: Trymer 2000 XP, HiTHERM HT-300, Duna Corafoam, Dyplast ISO-25, or approved equal meeting ASTM C 591.
1. ‘K’ Value: 0.19 at 75°F (24°C)
2. Maximum Continuous Service Temperature: 300°F.
3. Vapor Retarder Jacket: Saran 540/SSL or Mylar laminate.

D. Type PI-D: Hydrous Calcium Silicate: Johns Manville, IIG Thermo-12/Gold, ASTM C533; Rigid Molded Pipe:
1. ‘K’ Value: 0.40 at 300°F.
2. Maximum Service Temperature: 1,200°F.
HVAC INSULATION

3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression at 1½" thickness.
4. Tie Wire: 16 gauge stainless steel with twisted ends on maximum 12" centers.

E. Type PI-E: Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C522: Cellular Glass Thermal Insulation:
   1. 'K' Value: 0.35 at 75°F.
   2. Density: 8.0 lbs./cu. ft.
   3. Maximum Service Temperature: 900°F.
   4. Vapor Retarder Jacket – straight sections: Saran 540/SSL or Mylar laminate, factory applied with self sealing lap.
   5. Vapor Retarder Jacket - fittings: Saran 540/SSL spiral wrapped in field for fittings.

F. Type PI-F: Flexible Elastomeric Closed Cell Thermal Insulation: Armacel AP Armaflex, Rubatex K-Flex ECO, Aeroflex Aerocel, closed-cell, halogen free, elastomeric insulation, PDM Gel Copper polyethylene closed cell foam. Comply with ASTM-C177, ASTM E 84 and UL 181.
   1. 'K' Value: 0.27 at 75°F.
   2. Density: 3.0 to 6.0 lbs./cu.ft.
   3. Maximum Service Temperature: 260°F.
   4. Seal all seams and joints with contact adhesive.

G. Field Applied Jackets (For Interior Applications):
   1. All longitudinal seams shall be located on bottom of pipes.
   4. Aluminum Jacket: 0.016" thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
   5. Secure aluminum jackets with 3/8" or ½" stainless steel bands on 12" centers.

H. Field Applied Jackets (For Exterior Applications):
   1. All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.
   2. Aluminum Jacket: 0.016" (minimum) thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
   3. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
   4. Secure stainless steel or aluminum jackets with ⅜" or ½" stainless steel bands on 12" centers.
   5. Manufacturers: Pabco, Childers, RPR, or approved equal.

I. Removable Covers:
   1. Provide removable covers on pumps, valves, air separators, air vent fittings, flanges, strainers, steam traps, etc., where periodic maintenance or removal of insulation may be required.
   2. Use of pre-molded fittings with PVC covers is acceptable, unless noted otherwise.
      a. Cold systems: Provide PVC covers on elbows.
      b. Cold systems: Provide Armaflex elastomeric foam for flanges, valves, pumps and strainers.
      c. Hot systems: provide PVC covers on elbows and flanges.
      d. Hot Systems: provide removable blanket covers on valves, pumps, and strainers.
   3. Removable- type silicon cloth fiberglass filled insulating blankets:
      a. Mfg: Fit Tight Covers, GLT products, or equal custom fabrication by Insulation Contractor, 0-350°F service operating temperature:
         1) Jacket: silicon impregnated fiberglass cloth
         2) Liner: silicon impregnated fiberglass cloth
HVAC INSULATION

3) Liner reinforement : sstl mesh cloth
4) Insulation: 1" type E glass matt
5) Fastening: 2" nomex Velcro
6) Fastening: 1" straps and stainless steel D-rings
7) Fastening: 12 gage stainless steel hooks and stainless steel wire
8) Thread: Kevlar/stainless steel thread

b. Mfg: Fit Tight Covers, or equal custom fabrication by Insulation Contractor, 351-450°F service operating temperature:
   1) Jacket: silicon impregnated fiberglass cloth
   2) Liner: silicon impregnated fiberglass cloth
   3) Liner reinforement : sstl mesh cloth
   4) Insulation: 2" type E glass matt
   5) Fastening: 2" nomex Velcro
   6) Fastening: 1" straps and stainless steel D-rings
   7) Fastening: 12 gage stainless steel hooks and stainless steel wire
   8) Thread: Kevlar/stainless steel thread

2.8 EQUIPMENT INSULATIONS

A. Flexible Fiberglass Blanket: Johns Manville Microlite Type 75 Flexible Blanket:
   1. 'K' Value: ASTM C518, 0.27 Btu•in./(hr•ft²•ºF) at 75°F installed full thickness.
   2. Maximum Service Temperature: 250°F.
   3. Density: 0.75 lb/cu ft.
   4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Rigid Fiberglass Board: Johns Manville Spin-Glass 814
   1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
   2. Maximum Service Temperature: 250°F.
   3. Density: 3.0 lb/cu ft.
   4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

C. Note to Editor - This product is listed by J-M as compliant to PBDE ban in OR, CA, and WA:
   1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
   2. Maximum Service Temperature: 250°F.
   3. Density: 3.0 lb/cu ft.
   4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
   5. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)

D. Rigid Fiberglass Board for High Temperature: Johns Manville 1000 Spin-Glas Meeting ASTM C612; Rigid, Noncombustible:
   1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
   2. Maximum Service Temperature: 850°F.
   3. Density: 3.0 lb/cu ft.
   4. Facing: 1" galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)
HVAC INSULATION

E. Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F.
2. Density: 8.0 lb/cu. ft.
3. Maximum Service Temperature: 900°F.

F. Hydrous Calcium Silicate: Johns Manville, IIG Thermo-12/Gold Meeting ASTM C533; Rigid Molded Block; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
1. 'K' Value: 0.40 at 300°F.
2. Maximum Service Temperature: 1,200°F.
3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression, based on 1½" thickness.
4. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or ½" x .015" galvanized steel bands on 12" maximum centers for large areas.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that piping and ductwork has been tested for leakage in accordance with specifications before applying insulation materials. All piping and ductwork shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. General:
1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
2. Remove and replace any insulation that has become wet or damaged during the construction process.
3. Continue insulation and vapor barrier at penetrations and duct supports, except where prohibited by code. Instances where this is required include:
   a. Ductwork support angle or struts. To prevent crushing of low density insulation, provide separator or high density insulation at point of support. A 12 inch wide strip of Johns Manville Spin-Glass 817 6pcf density fiberglass board, or similar mfg/product, across the bottom side of the duct. Vapor barrier to continue unbroken at point of support.

B. Ductwork –Insulation on the Duct Exterior:
1. Provide insulated ductwork conveying air below ambient temperature (below room temperature) with vapor retardant jacket.
2. Seams/joints of ductwrap shall be secured with outward clinching galvanized staples spaced 4" O.C.. Vapor barrier tape shall not be used at the sole means of securing the insulation.
3. Seal all vapor retardant jacket seams and penetrations with 3" wide pressure-sensitive vapor barrier tape matching the insulation facing.
4. Provide insulated ductwork conveying air above ambient temperature (above room temperature) with or without vapor retardant jacket. Where service access is required, bevel and seal ends of insulation.
5. All exposed exterior metallic ductwork exposed or covered with cladding is to be built with a crown or reverse cross break to shed moisture.
6. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.
7. The insulation shall be firmly wrapped around the ducts with all joints lapped a minimum of 2” and secured with staples spaced 4" O.C.. The vapor barrier shall be sealed with FSK or metallic pressure sensitive tape. Installed thickness shall not exceed 25% compression. The underside of duct work 24” or greater in width shall be secured with mechanical fasteners and speed clips spaced approximately 18” on center. The protruding ends of the fasteners shall be cut off flush after the speed clips are installed, and then, when required, sealed with the same tape as specified above.

8. For ductwork exposed in mechanical equipment rooms below 7’ or in finished spaces, finish with Johns Manville Zeston 2000 PVC jacket.

9. For interior vapor/moisture conveying duct applications, install fiberglass insulation unless specifically indicated otherwise on drawings. Install to meet manufacturer’s requirements and as required by local code authorities.

10. For exterior applications, provide insulation with a weather protection jacket.

11. For exterior vapor duct applications, install fiberglass insulation with weatherproof jacket.

C. Type I Kitchen Grease Exhaust Ducts:
1. For grease ducts inside the conditioned building envelope but not in rated enclosures, install two-hour fire rated blanket wrap or duct board system to meet manufacturer’s requirements and as required by NFPA and local code authorities.

2. For grease duct outside the conditioned building envelope, install UL listed grease duct wrap insulation with weatherproofing jacket. Install to meet manufacturer’s requirements and as required by local code authorities.

D. Duct Liner:
1. Adhere insulation to sheet metal with a UL listed adhesive. Adhesive shall be applied to the sheet metal with a minimum coverage of 90%.

2. Secure insulation with mechanical liner fasteners as indicated by SMACNA or manufacturer. Pin length should be as recommended by the liner manufacturer.

3. All exposed edges of the liner must be factory or field coated. Unless factory coated, all transverse edges and longitudinal joints of the duct liner shall be coated. For systems operating at 4,000 fpm or higher, a metal nosing must be installed in all liner leading edges.

4. Repair liner surface penetrations with UL listed adhesive.

5. Duct dimensions indicated on plans are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

E. Piping Insulation:
1. Locate insulation and cover seams in least visible locations unless otherwise specified.

2. Neatly finish insulation at supports, protrusions, and interruptions.

3. Provide insulated dual temperature pipes and cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self sealing laps. Insulate complete system. No staples shall be used on pipes conveying fluids below ambient temperatures (cold systems).

4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.

5. Provide insert between support shield and piping on piping 1½” diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
   a. 1½” to 2½” pipe size: 10” long
   b. 3” to 6” pipe size: 12” long
   c. 8” to 10” pipe size: 16” long
   d. 12” and over: 22” long

6. Use of metal saddles is acceptable as specified in Section 230500. Fill interior voids with segments of insulation matching adjoining pipe insulation.

7. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Klo-Shure coupling or equal.
HVAC INSULATION

8. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers.

9. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.
   a. Cold systems: Provide Armaflex elastomeric foam for pumps and strainers.
   b. Hot Systems: provide removable blanket covers on valves, pumps, and strainers.

10. For exterior applications:
    a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
    b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.

11. For underground installations, install per manufacturer's written instructions and recommendations.

12. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

13. Special Application Requirements for Chilled Water Systems:
    a. Fiberglass insulation is not allowed.
    b. Pipe: Provide closed cell phenolic foam or cellular glass insulation for chilled and low temperature heat recover water piping and fittings.
    c. Non-factory vapor retarded piping and fittings: Spiral wrap insulation with Saran Vapor Retarder tape for fittings and. Cover with PVC jacket.
    d. 90/45/tee fittings: Provide material routed out of bun stock to the shape of the elbow, cut in half and applied to the fitting and spiral wrapped with Saran Vapor retarder tape. Cover with PVC fitting cover.
    e. Installation shall conform to Trymer Supercel or Pittsburg-Corning Foamglas installation guide.
    f. Valves, pipe flanges, pumps, strainers, gage fittings: may use Armaflex closed cell insulation in lieu of phenolic foam.

F. Equipment Insulation:
   1. See Piping Insulation above for additional requirements.
   2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer’s recommendations.
   3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
   4. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.
   5. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.
   6. Cover insulation with metal mesh and finish with heavy coat of insulating cement, mastic, or aluminum jacket as indicated in the drawings.
   7. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.
   8. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
   9. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced.
without damage. Use of silicon cloth fiberglass filled lace-on type insulation blankets is acceptable.

3.3 DUCTWORK INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed state energy code and mechanical code requirements as noted below. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior “K” factors.

B. All air distribution system ducts and plenums, but not limited to, building cavities, mechanical closets, air handler boxes, and support platforms uses as ducts or plenums, shall be installed, sealed, and insulated to meet the requirements of the code. Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum level of R-8.
   1. In a space between a non-insulated or below-code minimum insulated roof and an insulated ceiling.
   2. In a space directly under a roof with fixed vents or opening to the outside or unconditioned spaces
   3. In an unconditioned crawlspace.
   4. In other unconditioned spaces.

C. TABLE 1: DUCT WRAP INSULATION SERVICE, THICKNESS, AND MATERIAL TYPE REQUIRED.

D. Flexible Duct wrap:

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS/MATERIAL OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply ducts within building envelope</td>
<td>1-1/2</td>
<td>FSK</td>
<td>Type DW-A,B,C</td>
</tr>
<tr>
<td>Supply or return duct installed as exposed</td>
<td>0</td>
<td></td>
<td>Except where noted on</td>
</tr>
<tr>
<td>ductwork in the occupied space.</td>
<td></td>
<td></td>
<td>drawings for acoustical reasons.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply or return or outside air duct</td>
<td>1-1/2</td>
<td>Mylar</td>
<td>Applies to ISO rated Cleanroom</td>
</tr>
<tr>
<td>installed as exposed ductwork in the</td>
<td></td>
<td></td>
<td>spaces. Type DW-A,B</td>
</tr>
<tr>
<td>occupied clean rated space.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return ducts within building envelope</td>
<td>1-1/2</td>
<td>FSK</td>
<td>Type DW-A,B</td>
</tr>
<tr>
<td>Exterior/Outside supply and return ductwork</td>
<td>2-1/2</td>
<td>FSK</td>
<td>* or a thickness resulting in</td>
</tr>
<tr>
<td>sandwiched in double wall sheet metal</td>
<td></td>
<td></td>
<td>compressed R value=8</td>
</tr>
<tr>
<td>Supply and return ductwork located as</td>
<td>3</td>
<td></td>
<td>Type DW-A,B,C</td>
</tr>
<tr>
<td>described in 3.3.B above.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust ducts within 10 ft. of exterior</td>
<td>2</td>
<td>FSK</td>
<td>Type DW-A,B,C</td>
</tr>
<tr>
<td>openings</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E. Thicknesses in the above table shall have insulation values as follows: 1 1/2 “ = R=4.2, 2” = R-5.6, 3” = R-8.3. Greater thicknesses are permitted to achieve identical values if space constraints allow.

F. TABLE 2: DUCTWORK RIGID INSULATION AND PLENUM INSULATION SERVICE, THICKNESS, AND INSULATION TYPE REQUIRED.

G. Rigid and Plenum Insulation:
**HVAC INSULATION**

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS/MATERIAL OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside air intake ducts</td>
<td>2</td>
<td>FSK</td>
<td>Provide aluminum jacket over exterior installations. Type RB-A,B</td>
</tr>
<tr>
<td>Interior Plenums</td>
<td>2</td>
<td>FSK</td>
<td>Type RB-A,B</td>
</tr>
<tr>
<td>Exterior Plenums</td>
<td>2</td>
<td>FSK</td>
<td>Type RB-A,B</td>
</tr>
<tr>
<td>Supply, return and relief ducts in mechanical rooms and parking garages</td>
<td>2</td>
<td>FSK</td>
<td>Type RB-A,B</td>
</tr>
<tr>
<td>Vapor/moisture ducts installed exterior to the building envelope.</td>
<td>1-1/2</td>
<td>FSK</td>
<td>Provide jacketing on exterior ducts. Type RB-A,B</td>
</tr>
<tr>
<td>Exterior ductwork sandwiched in double wall sheet metal</td>
<td>2</td>
<td>FSK</td>
<td>Type RB-A,B</td>
</tr>
</tbody>
</table>

**H. TABLE 3: ACOUSTIC DUCT LINER SERVICE, THICKNESS, AND INSULATION TYPE REQUIRED.**

**I. Acoustic Duct Liner (rectangular ductwork):**

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS/MATERIAL OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where indicated 1” unless otherwise noted on plans</td>
<td>Air stream side coating</td>
<td>Type ADL-A,B,C,D</td>
<td></td>
</tr>
<tr>
<td>Exterior ductwork where indicated in double wall sheet metal sandwich construction.</td>
<td>2</td>
<td>Air stream side coating</td>
<td>Type ADL-A,B,C,D</td>
</tr>
<tr>
<td>Within 20’ of Air Handling Unit in supply and return ducts</td>
<td>1</td>
<td>Air stream side coating</td>
<td>Type ADL-A,B,C,D</td>
</tr>
</tbody>
</table>

**J. Acoustic Duct Liner (round ductwork):**

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>THICKNESS (inches)</th>
<th>FINISH</th>
<th>REMARKS/MATERIAL OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where indicated 1”</td>
<td>Air stream side coating</td>
<td>Type ADL-E</td>
<td></td>
</tr>
</tbody>
</table>

**K.** Thicknesses in the above table shall have insulation values as follows: 1 1/2” = R=4.2, 2” = R-5.6, 3” = R-8.3. Greater thicknesses are permitted to achieve identical values if space constraints allow.

**3.4 PIPING INSULATION SCHEDULE**

**A.** All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness 1/2” if exposed to exterior ambient air. Minimum thermal resistance shall comply with building code minimum ranges and may exceed those minimum levels. **Insulation thicknesses may be adjusted for equivalent insulation values for materials with superior “K” factors.**

**TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED**

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>FLUID TEMPERATURE RANGE (°F)</th>
<th>INSULATION TYPE / ALLOWED OPTIONS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Coil Condensate drain piping</td>
<td>(40°F -60°F)</td>
<td>Type PI-F</td>
<td>Provide ½” thickness insulation, all pipe sizes</td>
</tr>
</tbody>
</table>
HVAC INSULATION

Refrigerant suction and hot-gas piping

Type PI-F

Provide 3/4" thickness insulation, all pipe sizes.

Provide on all piping concealed in structure and close proximity to likely human contact

Refrigerant liquid piping

Provide aluminum jacket on exterior insulated suction piping / uninsulated liquid piping bundled together.

Chilled water supply and return systems and fittings

(40°F -60°F) Type PI-B, E

Provide 1" insulation thickness, all piping sizes.

Provide aluminum jacket on exterior insulated piping

Chilled water supply and return systems and fittings

(39°F and below) Type PI-B, E

Heating Water supply and return systems and fittings

(up to 200°F) Type PI-A, C, D, E, F

Low pressure steam supply and condensate systems

(250°F and below) Type PI-A, C, D, E

Medium and High pressure steam supply and Condensate systems

( greater than 250°F) Type PI-A, C, D, E

Steam condensate pump discharge systems

(141°F-200°F) Type PI-A, C, D, E

Steam Safety Valve Vent piping systems

Type PI-A, C, D, E

Electric Heat Traced systems

Provide 1" insulation thickness, all piping sizes.

Provide aluminum jacket on exterior insulated piping

B. TABLE 2: MINIMUM PIPING INSULATION THICKNESS BASED ON FLUID TEMPERATURE AND PIPING SIZE.

1. California

<table>
<thead>
<tr>
<th>FLUID TEMPERATURE RANGE (°F)</th>
<th>CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)</th>
<th>INSULATION MEAN RATING TEMPERATURE (°F)</th>
<th>NOMINAL PIPE DIAMETER (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insulation Based on California T-24 Energy Code Table 123-A Minimum Pipe Insulation Thicknesses or Greater</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Space heating systems (steam, steam condensate and hot water)

<table>
<thead>
<tr>
<th>FLUID TEMPERATURE RANGE (°F)</th>
<th>CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)</th>
<th>INSULATION MEAN RATING TEMPERATURE (°F)</th>
<th>NOMINAL PIPE DIAMETER (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 350</td>
<td>0.32-0.34</td>
<td>250</td>
<td>Runouts up to 2</td>
</tr>
<tr>
<td>251-350</td>
<td>0.29-0.31</td>
<td>200</td>
<td>1 and less</td>
</tr>
<tr>
<td>201-250</td>
<td>0.27-0.30</td>
<td>150</td>
<td>1-1/4-2</td>
</tr>
<tr>
<td>141-200</td>
<td>0.25-0.29</td>
<td>125</td>
<td>2-1/2-4</td>
</tr>
<tr>
<td>105-140</td>
<td>0.24-0.28</td>
<td>100</td>
<td>5-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 and larger</td>
</tr>
</tbody>
</table>

Service water-heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)

<table>
<thead>
<tr>
<th>FLUID TEMPERATURE RANGE (°F)</th>
<th>CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)</th>
<th>INSULATION MEAN RATING TEMPERATURE (°F)</th>
<th>NOMINAL PIPE DIAMETER (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 105</td>
<td>0.24-0.28</td>
<td>100</td>
<td>Runouts up to 2</td>
</tr>
<tr>
<td>40-60</td>
<td>0.23-0.27</td>
<td>75</td>
<td>1 and less</td>
</tr>
<tr>
<td>Below 40</td>
<td>0.23-0.27</td>
<td>75</td>
<td>1-1/4-2</td>
</tr>
</tbody>
</table>

2. Oregon
### HVAC INSULATION

#### Insulation Based on Oregon OEESC Energy Code for Minimum Pipe Insulation Thicknesses or Greater

<table>
<thead>
<tr>
<th>FLUID TEMPERATURE RANGE (°F)</th>
<th>CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)</th>
<th>INSULATION MEAN RATING TEMPERATURE (°F)</th>
<th>NOMINAL PIPE DIAMETER (in inches)</th>
<th>INSULATION THICKNESS REQUIRED (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Runout s up to 2</td>
<td>1 and less</td>
</tr>
<tr>
<td>Space heating systems (steam, steam condensate and hot water)</td>
<td></td>
<td></td>
<td>1 and less</td>
<td>1-1/4</td>
</tr>
<tr>
<td>Above 350</td>
<td>0.32-0.34</td>
<td>250</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>251-350</td>
<td>0.29-0.31</td>
<td>200</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>201-250</td>
<td>0.27-0.30</td>
<td>150</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>141-200</td>
<td>0.25-0.29</td>
<td>125</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>105-140</td>
<td>0.24-0.28</td>
<td>100</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Service water-heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 105</td>
<td>0.24-0.28</td>
<td>100</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Space cooling systems (chilled water, refrigerant and brine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-55</td>
<td>0.23-0.27</td>
<td>75</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Below 40</td>
<td>0.23-0.27</td>
<td>75</td>
<td>1.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

3. Washington

#### Insulation Based on Washington WSEC Energy Code Table 14-6 Minimum Pipe Insulation Thicknesses or Greater

<table>
<thead>
<tr>
<th>FLUID TEMPERATURE RANGE (°F)</th>
<th>CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)</th>
<th>INSULATION MEAN RATING TEMPERATURE (°F)</th>
<th>NOMINAL PIPE DIAMETER (in inches)</th>
<th>INSULATION THICKNESS REQUIRED (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Runout s up to 2</td>
<td>1 and less</td>
</tr>
<tr>
<td>Space heating systems (steam, steam condensate and hot water)</td>
<td></td>
<td></td>
<td>1 and less</td>
<td>1-1/4</td>
</tr>
<tr>
<td>Above 350</td>
<td>0.32-0.34</td>
<td>250</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>251-350</td>
<td>0.29-0.32</td>
<td>200</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>201-250</td>
<td>0.27-0.30</td>
<td>150</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>141-200</td>
<td>0.25-0.29</td>
<td>125</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>105-140</td>
<td>0.22-0.28</td>
<td>100</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Service water-heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above 105</td>
<td>0.22-0.28</td>
<td>100</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Space cooling systems (chilled water, refrigerant and brine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-60</td>
<td>0.22-0.28</td>
<td>75</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Below 40</td>
<td>0.22-0.28</td>
<td>75</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

### 3.5 EQUIPMENT INSULATION SCHEDULE

A. Equipment not factory insulated, including but not limited to:
   a. Heat exchangers.
   b. Converters.
   c. Chilled-water pumps.
   d. Outdoor condenser-water pumps.
   e. Heating, hot-water pumps.
   f. Heat-recovery pumps.
   g. Steam condensate pumps.
   h. Expansion/compression tanks.
   i. Air separators.
   j. Thermal storage tanks.
   k. Deaerators.
   l. Steam condensate tanks.
   m. Steam flash tanks, flash separators, moisture separators, and blow-off tanks.
   n. Outdoor condenser water system filtration unit housings.
### HVAC Insulation

- **o.** Outdoor, aboveground, heated, fuel-oil storage tanks.
- **p.** Generator exhaust systems.
- **q.** Removable Chiller Water Boxes.
- **r.** Water Softener Mineral Tanks.
- **s.** Hydronic service valves.
- **t.** Steam and Condensate service valves, 2" and larger.

### B. Rigid Fiberglass Board:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>THICKNESS (inches)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Condensate receivers</td>
<td>2</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Steam De-aerators</td>
<td>2</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Steam flash tanks, flash separators, moisture separators, and blow-off tanks</td>
<td>2</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Air separators</td>
<td>1 ½</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Expansion/compression tanks</td>
<td>1 ½</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Thermal storage tank</td>
<td>1 ½</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Water softener mineral tanks</td>
<td>1&quot;</td>
<td>Provide jacketing</td>
</tr>
</tbody>
</table>

### C. Flexible Elastomeric Foam (Closed Cell):

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>THICKNESS (inches)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold water storage tank</td>
<td>1 ½</td>
<td></td>
</tr>
<tr>
<td>Chilled water pump bodies</td>
<td>1 ½</td>
<td></td>
</tr>
<tr>
<td>Heat recovery water pump bodies</td>
<td>1 ½</td>
<td></td>
</tr>
<tr>
<td>Chilled water, heat recovery water air separator</td>
<td>1 ½</td>
<td></td>
</tr>
<tr>
<td>Chilled water, heat recovery water expansion/compression tanks</td>
<td>1 ½</td>
<td></td>
</tr>
<tr>
<td>Outdoor, aboveground, heated, fuel-oil storage tanks</td>
<td>1 ½</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Removable Chiller water boxes</td>
<td>1 ½</td>
<td></td>
</tr>
</tbody>
</table>

### D. Calcium Silicate:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>THICKNESS (inches)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator systems: Engine exhaust mufflers and piping</td>
<td>4</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Steam Condensate Receivers</td>
<td>2</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Steam De-aerators</td>
<td>2</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Heat exchangers/converters</td>
<td>1 ½</td>
<td>Provide jacketing</td>
</tr>
<tr>
<td>Steam flash tanks, flash separators, moisture separators, and blow-off tanks</td>
<td>2</td>
<td>Provide jacketing</td>
</tr>
</tbody>
</table>

### E. Removable Fiberglass Insulated Silicone Cloth Covers with Closure:

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>THICKNESS (inches)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating water air separators</td>
<td>1 ½</td>
<td></td>
</tr>
<tr>
<td>Heating water expansion/compression tanks</td>
<td>1 ½</td>
<td></td>
</tr>
</tbody>
</table>
## HVAC INSULATION

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot system thermal storage tank</td>
<td>1 ½</td>
</tr>
<tr>
<td>Heating water pump bodies</td>
<td>2</td>
</tr>
<tr>
<td>Heating water system valves, 2-1/2&quot; and larger</td>
<td>2</td>
</tr>
<tr>
<td>LP Steam system valves, 2&quot; and larger</td>
<td>2</td>
</tr>
<tr>
<td>MP, HP Steam system valves, 2&quot; and larger</td>
<td>2</td>
</tr>
<tr>
<td>Steam condensate system valves, 2&quot; and larger</td>
<td>2</td>
</tr>
<tr>
<td>Steam Condensate receivers</td>
<td>2</td>
</tr>
<tr>
<td>Steam De-aerators</td>
<td>2</td>
</tr>
<tr>
<td>Steam flash tanks, flash separators, moisture separators, and blow-off tanks</td>
<td>2</td>
</tr>
<tr>
<td>Steam condensate system pump bodies</td>
<td>2</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include but not necessarily be limited to the following:
   1. Provide new control components on all existing building systems. Existing control hardware reuse is allowed as approved by the University EMU facilities staff.
   2. Integrate existing building systems, renovated systems, and new systems to operate as one Building Automation System.
   3. Submit shop drawings of the entire control system components fully coordinated with major equipment suppliers' requirements. Provide proposed programming logic sequences of control functions on each system.
   4. Installation of control components other than valves, dampers and sensing wells as required for a complete and workable system.
   5. This Contractor shall furnish, install and coordinate the interlock and control wiring as specified and/or required for a complete and workable control system.
   6. Controls dampers are specified and furnished in Section 233113 of these specifications. Provide damper actuators, wiring and conduit as required to operate all dampers as shown.
   7. Upon completion of the installation, data entry and programming, provide complete validation and adjustment of specified control system through period of testing and Owner’s acceptance. The control contractor shall perform a point-to-point check out of all newly installed points to verify point existence, proper end to end connection and correct SI units with the Owners Representative.
   8. The entire program and sequence of operation with the final points list shall be verified by the Control Contractor, the Owners Representative, and signed by both parties. A copy of the final program, sequence of operation, and points list shall be submitted to the Engineer for approval and inclusion with the operation and maintenance manuals.
   9. Owner training on operation of the control system.
   10. One-year warranty on workmanship and materials.
   11. Interlocking of electrical systems and motors as shown on Drawings, except where specifically shown on electrical drawings.

1.3 RELATED WORK IN OTHER SECTIONS
A. Refer to Division 0 and Division 1 for related contractual requirements.
B. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.
C. Refer to Division 23 and the following sections for Mechanical or Electrical Provision.
   1. Section 013300 — Submittal Requirements
   2. Section 230800 — Commissioning
   3. Section 230500 — Basic Mechanical Materials and Methods
   4. Section 230901 — Laboratory Airflow Control
   5. Section 230902 — Variable Frequency Drives
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

6. Section 232113 — HVAC Piping, Valves, and Specialties
7. Section 233113 — Air Distribution
8. Section 235200 — Heat Generation Equipment
9. Section 236400 — Air Cooled Chillers
10. Section 236416 — Water Cooled Chillers
11. Section 236500 — Cooling Towers
12. Section 237312 — Custom Factory Air Handler
13. Section 237313 — Modular Air Handler
14. Section 238146 — Water Source Heat Pump
15. Section 238158 — VRV/VRF Systems
16. Section 230593 — Testing, Adjusting, and Balancing
17. Section 260001 — Basic Electrical Materials and Methods
18. Section 260519 — Wiring Methods
19. Section 260513 — Medium Voltage Electrical Power
20. Section 260519 — Low-Voltage Distribution
21. Division 28 – Electronic Safety and Security

D. Refer to Division 26 sections for Electrical Provisions. Sources of 120-volt electrical power as indicated on the electrical drawings and specifications for control system components furnished by this section. The controls contractor shall be responsible for all additional electrical distribution from these connection points to the control panels and other controls devices.

E. BAS contractor will furnish, but not install the following:
   1. Air flow measuring stations: furnish to mechanical installer and coordinate per manufacturer’s requirements.
   2. Flow meters: furnish to mechanical installer and coordinate per manufacturer’s requirements.
   3. Flow switches: furnish to mechanical installer and coordinate per manufacturer’s requirements.
   4. Hydronic pressure and temperature sensor wells: furnish to mechanical installer and coordinate per manufacturer’s requirements.
   5. Control valves: furnish to mechanical installer and coordinate per manufacturer’s requirements.

1.4 REFERENCE STANDARDS

A. The latest edition of the following standards and codes in effect and amended as of supplier’s proposal date, and any applicable subsections thereof, shall govern design and selection of equipment and material supplied:
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS


4. International Building Code (IBC), including local State and Local amendments.

5. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.


7. FCC Part 15, Subpart J, Class A.


9. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences.

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated, the system supplier shall secure and pay for all permits, inspections, and certifications required for his work, and arrange for necessary approvals by the governing authorities.

1.5 WORK INCLUDED

A. Furnish a distributed logic BACnet-based control system, including a Windows 7 Professional, Windows Server 2008 R2 or SQL Server 2008 R2-compatible operator’s workstation. The operator’s workstation, all building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2012, BACnet. Provide all necessary BACnet-compliant hardware and software to meet the system’s functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

B. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

C. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

D. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

E. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

F. Provide and install all interconnecting cables between all operator’s terminals and peripheral devices (such as printers, etc.) supplied under this section.

G. Provide complete manufacturer’s specifications for all items that are supplied. Include vendor name of every item supplied.

H. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

I. Provide a comprehensive operator and technician training program as described herein.

J. Provide as-built documentation, operator’s terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

K. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

1.6 SYSTEM DESCRIPTION

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

2012, BACnet and achieved listing under the BACnet Testing Laboratories BACnet - Advanced Workstation Software (B-AWS). This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, fan-coils, etc., and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

B. Operator’s workstation software shall use Windows 7 Professional, Windows Server 2008 R2 or SQL Server 2008 R2 as the computer operating system. The Energy Management and Control System (BAS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator’s terminal. Operator’s terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. All application controllers for every piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller through BACnet LAN.

E. Room sensors shall be provided with digital readout that allow the user to view room temperature, CO\textsubscript{2} or relative humidity, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow a technician to balance VAV zones and access any parameter in zone controller directly from the room sensor. Field service mode shall have the ability to be locked out.

1.7  APPROVED MANUFACTURERS

A. The base bid for controls shall be the BACnet system. Approved BAS Manufacturers/Contractors include:

1. Siemens
2. Automated Logic Corporation
3. Alerton
4. Johnson Controls
5. Honeywell

1.8  QUALITY ASSURANCE

A. The BAS shall be designed, installed, commissioned, and serviced by contractor authorized and trained personnel. System provider shall have an in-place support facility within two (2) hours response time of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.

B. The manufacturer and installer shall have a minimum of 5 years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. A list of successful past projects of similar type, size and complexity shall be submitted. In addition, a reference list of names, addresses and telephone numbers of the design Engineer and the Owner’s representative for each installation shall be provided. The references may be contacted and questioned about the timely delivery, installation, operation and service received for each installation.
C. The contractor shall provide experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of the BAS system.

D. The Bidder shall be regularly engaged in the design, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

E. Materials and equipment shall be manufacturer's latest standard design that complies with the specification requirements.

F. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

H. Control system shall be engineered, programmed and supported completely by representative’s local office that must be within 100 miles of project site.

I. Control components shall be products of the same manufacturer only, unless indicated otherwise and approved by Owner’s representative. Example – all valves shall by one manufacturer and all temperature sensors shall be by one manufacturer.

1.9 SUBMITTALS

A. Drawings
   1. The system supplier shall submit point-to-point engineered drawings, control sequence, and bill of materials for approval.
   2. Drawings shall be submitted in a standard size of 11” x 17” (ANSI B), as a minimum.
   3. Eight complete sets (copies) of submittal drawings shall be provided.
   4. Drawings shall be available on CD-ROM.

B. System Documentation
   1. Include the following in submittal package:
      a. System configuration diagrams in simplified block format.
      b. All input/output object listings and an alarm point summary listing.
      c. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
      d. Complete bill of materials, valve schedule with Cv, valve pressure drop at design flow, and damper schedule.
      e. Manufacturer’s instructions and drawings for installation, maintenance, and operation of all purchased items.
      f. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
      g. For all system elements—operator’s workstation(s), building controller(s), application controllers, routers, and repeaters—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2012.
      h. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.
      i. A list of all functions available and a sample of function block programming that shall be part of delivered system.

C. Project Management
   1. The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents, and shall indicate timing and dates for system installation, debugging, and commissioning.
1.10 WARRANTY

A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.

2. Respond during normal business hours within 24 hours of Owner’s warranty service request.

3. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

4. If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

5. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner’s written authorization.

6. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer’s acceptance.

PART 2 - PRODUCTS

2.1 OPERATOR’S WORKSTATION

A. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Clients shall access server for all archived data. Each client shall include flexibility to access graphics from server or local drive. Server shall support a minimum of 50 simultaneous clients.

B. Primary Operator Workstation Hardware

1. All workstations shall be general purpose microcomputer systems serving as an operator station in a cooperative processing server/client relationship with other connected workstations. The workstation shall consist of a high-speed central processing unit (CPU) with data storage facilities, high-resolution, 24”, LCD monitor. Components shall be capable of operating in environments of 60°F to 105°F and relative humidity of 30% to 90%.

2. The CPU in each workstation shall be Intel Pentium IV, 2 GHz or higher, Core 2 Duo also acceptable.

3. Memory: 8 GB (minimum)

4. Hard Drive: 500GB (minimum) for the BAS operating software

5. Hard Drive: 1 TB (minimum) to be used for trend log archiving.

6. Display: Video card and monitor capable of displaying 1920 x 1080 pixel resolution or greater.

7. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector, or greater).
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

D. Displays
1. In general, the operator’s workstation shall display all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD drawing files of field installation drawings and wiring diagrams from as-built drawings. Operator’s workstation shall display all data using three-dimensional graphic representations of all mechanical equipment.
2. A customized menu label (push-button) shall be used for display selection. Menu items on a display shall allow penetration to lower level displays or additional menus. Dynamic point information and menu label pushbuttons may be mixed on the same display to allow sub-displays to exist for each item. Each display may be protected from viewing unless operator has appropriate security level. A security level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
3. The BAS displays shall have the ability to link to content outside of the BAS system. Such content shall include but is not limited to: Launching external files in their native applications (for example, a Microsoft Word document) and launching a Web browser resolving to a specified Web address.
4. The BAS system shall have the ability to run multiple, concurrent displays windows showing continuously updated data.

E. Password Protection
1. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator’s assigned functions when user is logged on. This includes displays as outlined above.
2. Each operator’s terminal shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be capable of accepting 8 characters or more, User Name shall be 0–29 characters, and Passwords must accept a minimum of 4 characters and be capable of accepting 8 characters or more.
3. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.
4. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

F. Operator Activity Log
1. Operator Activity Log that tracks all operator changes and activities shall be included with system. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity log display.
2. Log shall be gathered and archived to hard drive on operator’s workstation as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

G. Scheduling
1. Operator’s workstation shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.

3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

4. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

H. Alarm Indication and Handling.

1. Operator’s workstation shall provide audible, visual, printed, email or test means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID’s authorization level.

2. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator’s terminal. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

3. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator’s terminal, client or through remote communication using email (Authenticated SMTP supported).

I. Trendlog Information

1. System server shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the operator’s workstation. Operator shall be able to view all trended records, both stored and archived. All trend log records shall be displayed in standard engineering units.

2. Software that is capable of graphing the trend logged object data shall be included. Software shall be capable of creating two-axis (X, Y) graphs that display up to 10 object types at the same time in different colors. Graphs shall show object values relative to time. Each trend log shall support a custom scale setting for the graph view that is to be stored continuously.

3. Operator shall be able to change trend log setup information. This includes the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.

4. System shall be capable of using Microsoft SQL as the system database.

J. Energy Log Information

1. System server shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.

2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

3. Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.

4. System shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

K. Demand Limiting

1. System shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.

2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.

3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.

4. Status of each and every load shed program shall be capable of being displayed on every operator terminal connected to system. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

L. Tenant Activity

1. System shall include program that monitors after-hours overrides by tenants, logs that data, and generates a bill based on usage and rate charged for each tenant space. Tenant Activity program shall be able to assign multiple zones, from a list of every zone connected to system, to a particular tenant. Every zone is monitored for after-hour override usage and that data logged in server. Operator may then generate a bill based on the usage for each tenant and the rate charged for any overtime use.

2. Configuration shall include entry of the following information for use in logging and billing:
   a. Tenant’s contact name and address.
   b. One or multiple tenant zones that make up a total tenant space, including a separate billing rate for each separate zone.
   c. Minimum and maximum values an event duration and event limit.
   d. Property management information.
   e. Overall billing rate.
   f. Seasonal adjustments or surcharge to billing rate.
   g. Billing notification type such including, but not limited to printer, file and email.
   h. Billing form template.
   i. Logging shall include recording the following information for each and every tenant event.
      j. Zone description.
      k. Time the event begins.
      l. Total override time.
      m. Limits shall be applied to override time.

3. A tenant bill shall be generated for a specific period using all the entered configuration data and the logged data. User with appropriate security level shall be able to view and override billing information. User shall be able to select a billing period to view and be able to delete events from billing and edit a selected tenant activity event’s override time.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

M. Reports
1. System server shall be capable of periodically producing reports of trend logs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.
2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

N. Configuration/Setup
1. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

O. Field Engineering Tools
1. Operator’s workstation software shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
2. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
3. System shall automatically notify the user when a device that is not in the database is added to the network.
4. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.
5. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

P. Workstation Hardware
1. Workstation/server computer minimum requirements
   a. Enterprise Server (supports heavy trending and/or alarm handling at very large sites using SQL Server)
   b. Windows 7 Professional, Windows Server 2008 R2, SQL Server 2008 R2
   c. Browser/client requirements: Most current versions of the following: Internet Explorer, Firefox, Safari (on Mac OS X).

Q. Software
1. At the conclusion of project, contractor shall leave with owner a DVD ROM that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner how to completely restore the system in the case of a computer malfunction.

2.2 WEB INTERFACE

A. General
1. BAS supplier shall provide Web-based access to the system as part of standard installation. User must be able to access all displays of real-time data that are part of the BAS using a standard Web browser. Web browser shall tie into the network through owner-supplied Ethernet network connection. Web page host may be a separate device that resides on the BAS BACnet network, but is not the BAS server for the control system. BAS server may be a separate computer from the Web page host device. The
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

Web page software shall not require a per-user licensing fee or annual fees. The Web page host must be able to support simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

B. Browser Technology
   1. No special vendor-supplied software shall be needed on computers running browser. All displays shall be viewable and the webpage host shall directly access real-time data from the BAS BACnet network. Data shall be displayed in real-time and update automatically without user interaction. User shall be able to change data on displays if logged in with the appropriate user name and password.

C. Communications
   1. Web page host shall support Ethernet network connections. A network connection shall be used to gather real-time data from all the BACnet devices that form the BAS. This network shall communicate using BACnet, allowing the Web page host to gather data directly from units on the local LAN or from other projects connected over a WAN. This network shall also provide the connection to the BAS server for Web page generation.
   2. An Ethernet connection shall provide the physical connection to the Internet or an IP-based WAN. It shall be the port that is used for the browser to receive Web pages and data from the Web page host. The Web page host shall act as a physical barrier between the BAS network and the WAN or Internet connection that allows the browser to receive Web pages and data. The two separate network connections provide for a physical barrier to prevent raw BACnet traffic being exposed on the IP network.
   3. The Web page host shall provide for complete isolation of the IP and BACnet networks by not routing networking packets between the two networks.

D. Display of Data
   1. Web page graphics shown on browser shall be replicas of the BAS displays. User shall need no additional training to understand information presented on Web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays. Fans shall turn, pilot lights shall blink, coils shall change colors, and so on.
   2. Real-time data shall be shown on all browser Web pages. This data must be directly gathered using the BACnet network and automatically updated on browser Web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.
   3. It shall be possible for user from browser Web page to change data if the user is logged on with the appropriate password. Clicking on a button or typing in a new value shall change digital data. Using pull-down menus or typing in a new value shall change analog data.
   4. Data displays shall be navigated using pushbuttons on the displays that are simply clicked on with the mouse to select a new display. Alternatively, the standard back and forward buttons of the browser can be used for display navigation.

E. Time Schedule Adjustment
   1. Web access shall allow user to view and edit all schedules in the system. This includes three types of schedules: standard, holiday and event. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
   2. Display of all three schedule types must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

F. Logging of Information
1. User shall use standard browser technology to view all trendlogs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust Y axis of data viewed in graphical format. User shall also be able to download data through the Web interface to local computer. Data shall be in CSV format.

G. Alarm Handling
1. Web interface shall display alarms as they occur. User shall be able to acknowledge alarms using browser technology. In addition, user shall be able to view history of alarm occurrence over a user-selected time frame. In addition, those alarms may be filtered for viewing per user-selected options. A single selection shall display all alarms that have not been acknowledged.

H. Web Page Generation
1. Web pages shall be automatically generated from the BAS displays that reside on the BAS server. User shall access Web page host through the network and shall initiate a Web page generation utility that automatically takes the BAS displays and turns them into Web pages. The Web pages generated are automatically installed on the Web page host for access using any computer’s standard browser. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.

I. Password Security and Activity Log
1. Access through Web browser shall utilize the same hierarchical security scheme as BAS system. User shall be asked to log on once the browser makes connection to Web page host. Once the user logs in, any and all changes that are made shall be tracked by the BAS system. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged in to the system, regardless of whether those changes were made using a browser or through the BAS workstation.

J. BACnet Communication
1. Web server shall directly communicate to all devices on the BAS network using BACnet protocol. No intermediate devices shall be necessary for BACnet communication.

2.3 BUILDING NETWORK CONTROLLER

A. Building Network Controller
1. BACnet Conformance
   a. Building Network Controller shall be approved by the BACnet Testing Laboratories as meeting the BACnet Building Controller requirements.

B. Building network controller modules shall provide normal 7-day scheduling, holiday scheduling and event scheduling.
1. Logging Capabilities
   a. Logs shall be supported in the building network controller. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator’s workstation.
   b. Logs may be viewed both on-site or off-site using WAN or remote communication.
   c. Building network controller shall periodically upload trended data to networked operator’s workstation for long-term archiving if desired.
   d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

2. Alarm Generation
   a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
   b. Each alarm may be dialed out as noted elsewhere.
   c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator’s terminal or off-site using remote communications.
   d. Controller must be store alarms as BACnet event enrollment objects, with system destination and actions individually configurable.

3. Demand Limiting
   a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 200 loads using a minimum of two types of shed programs.
   b. Load shedding programs in building controller modules shall operate as defined in Section 2.1 Demand Limiting of this specification.

4. Tenant Activity Logging
   a. Tenant activity logging shall be supported by building network controller module.
   b. Tenant activity logging shall function as defined in Section 2.1 Tenant Activity Logging of this specification.

C. Ethernet – MS/TP Module
   1. Ethernet – MS/TP Module shall support every function as listed under paragraph A, General Requirements, of this section and the following.
   2. All communication with operator’s workstation and all application controllers shall be through BACnet. Building controller Ethernet – MS/TP module shall incorporate as a minimum, the functions of a 2-way BACnet router. Controller shall route BACnet messages between the high-speed LAN (Ethernet 10/100MHz) and MS/TP LAN. Ethernet – MS/TP module shall also route messages from all other building controller modules onto the BACnet Ethernet network.
      a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.
      b. The RJ-45 Ethernet connection must accept either 10Base-T or 100Base-TX BACnet over twisted pair cable (UTP).

D. MS/TP Module
   1. MS/TP module shall support every listed function in this specification and the following.
   2. Building controller MS/TP module communications shall be through BACnet MS/TP LAN to all advanced application and application-specific controllers. MS/TP module shall also route messages to Ethernet – MS/TP module for communication over WAN.
      a. MS/TP LAN must be software-configurable from 9.6 to 76.8Kbps.
      b. Configuration shall be through RS-232 connection.

E. Power Supply Module
   1. Input for power shall accept between 17–30VAC, 47–65Hz.
   2. Power supply module shall include rechargeable battery for orderly shutdown of controller modules including storage of all data in flash memory and for continuous operation of real-time clocks for minimum of 20 days.

F. Modbus Module
   1. Modbus Module shall support every function as listed in this specification
   2. Building Controller Modbus module communications shall be via one of three types of ports: EIA-485, EIA-422 or RS-232 connection. Modbus module shall convert Modbus data into BACnet objects. Modbus module shall also route messages to Ethernet-MS/TP module for BACnet Ethernet communication over WAN.
      a. Modbus Module shall support ASCII or RTU Modbus communication at 9600 or 4800 baud.
      b. EIA-422 and EIA-232 connection shall support one connection of Modbus unit.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

c. EIA-485 connection shall support connection of up to 247 Modbus units.
d. Configuration shall be via RS-232 connection.

3. BACnet Translation
   a. All Modbus data shall be translated into BACnet objects by the Modbus module. All configuration tools shall be supplied to assure data is translated as necessary to the correct format and value.
   b. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2.4 APPLICATION CONTROLLERS – GENERAL

A. All application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.

B. All program sequences shall be stored on board controller in memory. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.

C. Provide all application controllers with a minimum of 10% spare points for analog input, analog output, digital input and digital output signals.

2.5 APPLICATION CONTROLLERS – AIR HANDLER OR CENTRAL PLANT

A. Provide one or more native BACnet application controllers to adequately cover all objects listed in object list. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.

B. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator’s terminal section.

C. Application controller shall include support for intelligent room sensor. Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

D. Schedules
   1. The controller shall support a minimum of three (3) BACnet Schedule Objects and have a real-time clock on board with battery backup to maintain time through a power loss.

E. Logging Capabilities
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

1. Controller shall support a minimum of 50 trend logs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator’s workstation.

2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

F. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.

2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator’s terminal or off-site using remote communications.

3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

G. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

2.6 APPLICATION CONTROLLER – UNITARY MECHANICAL EQUIPMENT

A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.

2.7 APPLICATION CONTROLLER - VAV BOX—SINGLE DUCT

A. Provide one native BACnet application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include on board CFM flow sensor, inputs, outputs and programmable, self-contained logic program as needed for control of units.

B. On board flow sensor shall be microprocessor-driven and pre-calibrated at the factory. All factory calibration data shall be stored in non-volatile memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator’s workstation, portable computers, and special hand-held field tools shall not be needed for field calibration.

C. Provide duct temperature sensor at discharge of each VAV box that is connected to controller for reporting back to operator’s workstation.

2.8 APPLICATION CONTROLLER - VAV BOX—DUAL DUCT

A. Provide one BACnet application controller for each dual-duct VAV box that adequately covers all objects listed in object list for unit. Systems that use two or more controllers for control of a single dual-duct box shall be rejected. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include two (2) on-board flow sensors, inputs, outputs and self-contained logic program as needed for control of units.

B. On-board flow sensor shall be microprocessor driven and pre-calibrated at the factory. Pre-calibration shall be at 16 flow points as a minimum. All factory calibration data shall be stored in memory. Calibration data shall be field adjustable to compensate for variations in VAV box type and installation. All calibration parameters shall be adjustable through intelligent room sensor. Operator workstation, portable computers and special hand-held field tools shall not be needed for field calibration.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

C. Provide duct temperature sensors at discharge of cold duct and hot duct for report of data at operator workstation.

2.9 AUXILIARY CONTROL DEVICES

A. Temperature Sensors
   1. Duct mount, indoor
      a. Veris TF series 10K ohm, type II thermistor with stainless steel probe and junction box, or equal.
   2. Duct mount, outdoor
      a. Veris TF series 10K ohm, type II thermistor with stainless steel probe and weather-tight junction box, or equal.
   3. Outside air
      a. Veris TO series 10K ohm, type II thermistor with stainless steel probe encased in durable radiation shield with weather-tight junction box, or equal.
   4. Pipe insertion
      a. Veris TIG series 10K ohm, type II thermistor with corrosion resistant stainless steel probe, thermowell, and standard or weather-tight junction box as required, or equal.
   5. Averaging
      a. Veris TA series 10K ohm, type II thermistor encased in flexible copper tubing to enhance response time, or equal. Provide with standard or weather-tight junction box as required. Mounting of tubing shall utilize AA64 mounting clips.

B. Intelligent Room Temperature Sensor with LCD Readout
   1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit and allow occupant to raise and lower setpoint, and activate terminal unit for override use-all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
   2. The intelligent room sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display time-of-day, room humidity and outdoor humidity. Unit must have the capability to show temperatures in degrees Fahrenheit or Centigrade.
   3. Override time may be set and viewed in half-hour increments. Override time countdown shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word “OFF” in unoccupied mode unless a function button is pressed.
   4. See sequence of operation for specific operation of LCD displays and function keys in field service mode and in normal occupant mode. Provide intelligent room sensors as specified in point list. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.

C. Operable Window Sensors
   1. In areas of new construction, window sensors shall be provided to indicate open/closed status and shall integrate into the BMS sequence of operation.
   2. Provide 3/8” diameter recessed switch set window sensors with magnetic contacts.
   3. Sensors shall be hermetically sealed and shall resist sticking or freezing
   4. Switches and magnets shall have lifetime warranty
   5. GRI 2020-T Series or equiv.

D. Wireless Wall Sensor
   1. Wireless wall sensor shall use solid-state sensor and shall be packaged in aesthetically pleasing enclosure. Sensor shall provide override function, warmer/cooler dial for set
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

point adjustment. Override time shall be stored in controller and be adjustable on a zone-by-zone basis. Adjustment range for warmer/cooler lever shall also be stored in EEPROM on controller. All programmable variables shall be available to field service tool through wall sensor port. There shall be a mechanical means the lock the wall sensor to the base to prevent theft and vandalism.

2. Wireless wall sensor shall have a battery life of five (5) years with alkaline batteries and 7.5 years with lithium batteries. A low battery indication shall be signaled to the controller prior to the battery being exhausted. The wireless sensor shall run on industry standard AA style batteries.

3. The wireless range in open air shall meet or exceed 3000 feet. The strength of the wireless signal must be indicated at the wireless sensor to aid in placement and trouble shooting. The receiver shall have a wireless communications received light that indicates the proper communication is occurring.

4. The wireless wall sensor and receiver must be paired in an addressable means to facilitate easy replacement and reassignment.

E. Humidity Sensors

1. Wall mount:
   a. Veris HW series humidity, 2% accuracy thin film capacitive replaceable sensor element, LED display, or equal.

2. Outside air:
   a. Veris HO series humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing, or equal.

3. Duct:
   a. Veris HD series humidity sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing, or equal.

4. Wall mount, with temperature:
   a. Veris HW series combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, LED display, push button override and setpoint slider, or equal.

5. OSA, with temperature:
   a. Veris HO series combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with weatherproof housing, or equal.

6. Duct, with temperature:
   a. Veris HD series combination humidity and temperature sensor, 2% accuracy thin film capacitive replaceable sensor element, with die cast metal housing, or equal.

7. High limit switch:
   a. Honeywell H6045A1002 duct mount hygrostat with insertion probe, adjustable trip dial, and NO and NC contacts, or equal.

F. Dewpoint Sensors

1. Wall mount:
   a. Kele Vaporstat 9002 wall mount dew point transmitter with non-dispersive infrared sensor and blank cover, or equal. Accuracy +/- 3.6° F.

G. Moisture Sensor, pipe, strap on:
   a. Honeywell model HSS-DPS early warning dew point switch, strap on, with status light with NO and NC alarm terminals, or equal.

H. CO2 Sensors

1. Room, wall mount
   a. Veris CWE series with non-dispersive infrared sensor, repeatable to +/- 20 ppm, or equal.

2. Outdoor and Duct
   a. Veris CDE series with non-dispersive infrared sensor, repeatable to +/- 20 ppm, or equal.

I. CO2, Humidity, Temperature Combined Sensor (Duct and Wall)
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

1. Veris C Series Deluxe Duct and Wall CO2 sensor with set point slider and LCD display, or equal.
   a. CO2 sensor with non-dispersive infrared sensor, repeatable to +/- 20 ppm.
   b. Humidity Sensor digitally profiled thin-film capacitive, plus or minus 2% RH.
   c. Temperature Sensor: Thermistor

J. Leak Detector
1. Condensate pan overflow detection:
   a. Veris SD-R01 detector, 24V AC, with automatic reset, and 14 foot cable, or equal.

K. Differential pressure transmitters: Duct, building static, and water pressure
1. Duct Static Pressure Transmitter
   a. Veris PX series differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero, LCD display, or equal.
2. Building Static Pressure Transmitter
   a. Veris PX series differential pressure transducer with selectable range, +/- 1% accuracy, with push button auto-zero. Provide with AA05 ceiling mount static pressure pick up, LCD display, or equal.
3. Water differential pressure transmitter
   a. Veris PW2 series differential pressure transmitter, wet/wet, switch selectable pressure ranges, jumper selectable port swap, LCD display and NEMA 4 enclosure, or equal.

L. Differential pressure switches
1. Filter differential pressure switch for status
   a. Dwyer Series ADPS adjustable differential pressure switch, dual scale adjustable knob, silicone diaphragm and NEMA 13 enclosure, or equal.
2. Duct static pressure hi-low pressure safety switch for fan shut down
   a. Dwyer Series 1900MR with adjustable trip and manual reset, or equal.

M. Current Sensors
1. Current sensing switch for fans, pumps, etc.:
   a. Hawkeye Hx08 series current switch with split core, adjustable trip, pilot light, self-gripping split core housing and mounting bracket, or equal.
2. Current sensing switch for VFD’s:
   a. Hawkeye H614 Automatic VFD current switch split core, self-learning adjustable trip, pilot light, self-gripping split core housing and mounting bracket, or equal.
3. Current sensing switch with relay for fan start
   a. Hawkeye H 900 series current switch with split core, integral relay, adjustable trip, pilot light, self-gripping split core housing and mounting bracket, or equal.
4. Current sensing transmitter
   a. Hawkeye H921 current sensing transmitter with self-gripping split core, preset slide switches, and removable mounting bracket, or equal.
5. Current sensing transmitter with relay for fan start
   a. Hawkeye H931 current sensing transmitter with integral relay, slide switches, self-gripping split core, and removable mounting bracket, or equal.

N. Flow Meters Liquid:
1. Onicon F-1100 single turbine insertion flow meter, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1” full port bronze ball valve, close nipple, and branch outlet. Provide with D-100 totalizing display module with BACnet interface, or equal.
2. Onicon F-3500 electromagnetic insertion flow meter, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1” full port bronze ball valve, close nipple and branch outlet. Provide with D-100 totalizing display module with BACnet interface, or equal.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

O. Flow Meters Natural Gas
   1. Onicon F-5100 Series thermal mass flow meter, in-line or flanged as required, or equal. Provide with D-100 totaling display module with BACnet interface.

P. Flow Meters Steam
   1. Steam: Onicon F-2500 series vortex flow meter, integral 1,000 Ohm platinum RTD for precise temperature measurement, pressure transducer for instantaneous pressure measurement, flow straightener, ANSI class 300 flanges, or equal.

Q. BTU Meters
   1. Onicon System-10-BAC BTU meter with BACnet interface with matched temperature sensors and thermo-wells, NEMA 13 wall mount enclosure, or equal. Provide with Onicon F-1100 single turbine insertion flow meter, or Onicon F-3500 electromagnetic flow meter, 316 stainless steel, weather tight aluminum enclosure, and standard or copper installation kit including 1" full port bronze ball valve, close nipple, and branch outlet.

2.10 ACTUATORS

A. Electronic Actuators
   1. Manufactured, brand labeled or distributed by Belimo, or equal.
   2. Size for torque required for damper seal at load conditions.
   3. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
   4. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
   5. Overload protected electronically throughout rotation.
   6. Fail-Safe Operation: Mechanical, spring-return mechanism
   7. Electronic Fail-Safe Operation: Incorporate a visual indication of the fail safe status on the face of the actuator. The power fail position shall be field adjustable between 0 to 100% in 10o increments. The electronic fail safe shall have a 2-10 second adjustable operational delay.
   8. Power Requirements (Spring Return): 24-V ac, maximum 10 VA at 24-V ac or 8 W at 24-V dc (running). Maximum 1 VA at 24-V ac or 1 W at 24-V dc (holding).
   9. Proportional Actuators shall be fully programmable through an onboard EEPROM by using an external cable and software interface.
   10. Temperature Rating: -22 to +122ºF.
   11. Housing: Minimum requirement NEMA type 2 mounted in any orientation.
   12. Agency Listings: ISO 9001, cULus, CE or CSA
   13. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

B. Actuators with torque requirements exceeding 360 inch pounds
   1. Manufactured, brand labeled or distributed by Belimo, or equal.
   2. The combination of valve and actuator shall meet the close-off requirements as specified in Section 2.16.H – Butterfly Valves.
   5. Manual Override: Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of an electrical power failure.
   7. Auxiliary Switches: 2 SPDT rated 3A at 250 VAC.
   8. Temperature Rating: -22 to +150ºF.
   9. Duty Cycle Rated 75% minimum.
   10. Housing: Minimum requirement NEMA type 4X/ IP67 with an industrial quality coating. Actuator shall have an internal heater to prevent condensation within the housing. A visual indication beacon shall indicate position status of the device.
   11. Agency Listing: ISO, CE, CSA
   12. The manufacturer shall warrant for 2 years from the date of production.
2.11 CONTROL VALVES

A. Manufacturer:
1. Manufactured, brand labeled or distributed by Belimo, or equal.

B. Control Valve Actuators:
1. Size for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
2. Coupling: directly couple and mount to valve stem, shaft ISO-style direct-coupled mounting pad.
3. Non-spring return actuators shall have manual override.
4. Spring return actuators of 90 inch-pounds or above shall have manual override.

C. Control Valves:
1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
2. Sizing (Water):
   a. Two-Position: Line size or size using a pressure differential of 1 psi.
   b. Two-Way Modulating: Size for a pressure differential across the valve of 4 psi at design flow, or twice the load pressure drop at design flow.
   c. Three-Way Modulating: Size for a pressure differential across the valve of not more than 4 psi at design flow.
3. Sizing (Steam):
   a. Two-Position: Line size or sized using 10% of inlet gauge pressure.
   b. Modulating: 15 psig or less inlet steam pressure, the pressure drop shall be 80% of inlet gauge pressure. Higher than 15 psig inlet steam pressure the pressure drop shall be 42% of the inlet absolute pressure.
4. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system head pressure for two-way valves and 150 percent of the design pressure differential across the three-way valves.
5. The control valve assembly shall be provided and delivered from a single manufacturer as a complete assembly.

D. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

E. Pressure Independent Control Valves
1. NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc for equal percentage characteristic.
2. NPS 2-1/2 through 6: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
3. The control valve assembly shall have an integral magnetic flow meter Magnetic flow meter to accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve with a valve body accuracy of +/- 5% variance due to differential pressure fluctuation or +/- 10% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
4. Flow Characteristics: NPS 1/2” through 2” Equal percentage characteristic. NPS 2-1/2” through 6” capable of Equal percentage or Linear characteristic (field programmable).
5. All proportional actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.
6. Actuators for 3-wire floating (tri-state) and on 2 position (on/off) on 1/2” to 1” pressure independent control valves shall fail in place.
7. Water Coil optimization 2-1/2" through 6" shall be accomplished by utilizing Belimo’s energy meter (a pressure independent control valve assembly) with two integral temperature sensors providing feedback of coil inlet and coil outlet water temperature; and integral magnetic flow meter for control and to provide actual analog flow feedback. Valve assembly to have built in intelligence to control pressure independently and a Delta T Manager mode to mitigate low delta T syndrome by referencing an internally programmed design delta T setpoint. Valve assembly shall be capable of communicating data by means of BACnet MS/TP, BACnet I/P and TCP IP. Data to include, but not be limited to, inlet and outlet coil water temperatures, valve position, absolute flow, absolute valve position, absolute power and heating/cooling energy in BTU/hr. Valve assembly shall be capable of trending and storing up to 13 months of data on the actuator. Trended data on actuator to be retrievable via TCP IP or direct connect and download to *.csv file format.

8. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

9. The control valve shall require no maintenance and shall not include replaceable cartridges.

10. NPS 2” and smaller pressure independent control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain an integrated isolation ball valve/manual air vent with strainer/shut-off valve/drain with pressure/temperature test ports. The return side shall contain a union fitting with a pressure/temperature test port, pressure independent control valve, and integrated isolation ball valve/manual air vent with a pressure/temperature test port. Shut-off valves as an integrated part of the pressure independent control valve are prohibited. A braided stainless flexible hose shall be provided for each coil supply and return connection for all pipe packages.

F. Characterized Control Valves:

1. NPS 1/2" and smaller for Terminal Units : Nickel plated forged brass body rated at no less than 600 psi WOG Water oil gas, chrome plated brass Stainless steel stem is an option ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

2. NPS 1" through 2": Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

3. NPS 2-1/2" through 6": GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball, stainless steel blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring package design, PTFE seats, and a stainless steel flow characterizing disc.


5. Six-way control valve used for chilled beam applications shall have the following characteristics:

   a. NPS 1/2" and 3/4": Nickel plated forged brass body rated at no less than 600 psi, dual chrome plated brass ball and blowout proof stems, and female NPT end fittings. Each three-way portion of the 6-way valve body shall have EPDM O-Ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.

   b. The six-way control valve shall be controlled by a rotary actuator for managing two media in a modulating application. The valve shall be closed to all flow at mid-rotation.

G. Butterfly Valves – Resilient Seat:
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

1. NPS 2 to 12: Valve body shall be full lugged cast iron 200 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize an internal spline. The shaft shall be supported at four locations by RPTFE bushings.

2. NPS 14 and Larger: Valve body shall be full lugged cast iron 150 psig body with a 304 stainless steel disc, EPDM seat, extended neck and shall meet ANSI Class 125/150 flange standards. Disc-to-stem connection shall utilize a dual-pin method to prevent the disc from settling onto the liner. The shaft shall be supported at four locations by RPTFE bushings.

3. Sizing:
   a. Two-Position: Line size or size using a pressure differential of 1 psi.
   b. Modulating: 4 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position and a design velocity not to exceed 12 feet per second.


H. Butterfly Valves – High Performance:

1. Valve body shall be full lugged carbon steel ANSI Class 150 [300] body with a 316 stainless steel disc without a nylon coating, RTFE seat, and be ANSI Class 150300 flange standards. Blowout-proof shaft shall be 17-4ph stainless steel and shall be supported at four locations by glass-backed TFE bushings. Valve packing shall be Chevron TFE and shall include fully adjustable packing flange and separable packing gland. Valve body shall have long stem design to allow for 2” insulation (minimum). Valve face-to-face dimensions shall comply with API 609 and MSS-SP-68. Valve assembly shall be completely assembled and tested, ready for installation.

2. Sizing:
   a. Two-Position: Line size or size using a pressure differential of 1 psi.
   b. Modulating: 4 psig or twice the load pressure drop, whichever is more. Size for the design flow with the disc in a 60-degree-open-position with the design velocity less than 32 feet per second.


6. Max Differential Pressure: 285 psi @ 100 deg F for ANSI 150 (725 psi @ 100 deg F for ANSI 300).

2.12 ENCLOSURES

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment.

C. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

D. Outdoor enclosures shall be NEMA 3R.

E. Enclosures shall have hinged, locking doors.

F. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 0.125 inches thick and appropriately sized to make label easy to read.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

B. Notify the owner’s representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

3.2 INSTALLATION (GENERAL)

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections, installation, and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3 feet of clear access space in front of units. Obtain approval on locations from owner’s representative prior to installation.

B. Wall mounted temperature sensors will typically be mounted directly above or below light switches and comply with ADA height requirements. Coordinate with owner, architect and other trades to assure proper mounted locations prior to installation.

C. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture, and high or low temperatures.

D. Identify all equipment and panels. Provide permanently mounted tags for all panels.

E. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections, and sized to suit pipe diameter without restricting flow.

3.4 CONDUIT

A. Conduit Requirements: all conduit shall with comply with minimum requirements of local authority having jurisdiction.

1. Low voltage wiring in concealed areas may be plenum rated. Low voltage wiring in exposed areas shall be enclosed in conduit.
   a. All low voltage wiring exposed to weather shall be installed in conduit.
   b. Low voltage wiring in exposed areas, such as in mechanical, electrical, or service rooms, shall be installed in EMT conduit up to 10 feet above finished floor.

2. All low voltage control wiring shall be enclosed in conduit.

B. Provide conduit for low voltage wiring in walls for all wall mounted sensors, CO2 sensors, humidity sensors, etc. Conduit shall be run to 6” above the ceiling and shall terminate with a bushing installed on the conduit end.

C. Provide conduit for low voltage wiring above inaccessible ceilings.

D. Conduit must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

E. Secure conduits with conduit clamps fastened to the structure and spaced according to code requirements. Conduits and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

F. Size of conduit and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer’s recommendations and NEC requirements, except as noted elsewhere.
3.5 LOW VOLTAGE INTERLOCKING AND CONTROL WIRING

A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification. Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.

B. All low-voltage wiring shall meet NEC Article 725 Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.

C. Do not install Class 2 wiring in conduits containing Class 1 wiring. Boxes and panels containing line voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

D. Unless otherwise noted, power wiring for all valve and damper actuators is Class 2. If the BAS contractor desires to substitute 120 V actuators, the BAS contractor shall provide all Class 1, 120V wiring and conduit at own expense.

E. Contractor shall provide step-down transformers as necessary.

F. Install insulated bushings on all conduit ends and openings to enclosures. Seal top end of vertical conduits.

G. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block. Wire nuts are not acceptable.

H. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

I. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

J. Use color-coded conductors throughout with conductors of different colors.

K. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

L. The contractor shall terminate all communications, control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

3.6 COMMUNICATION WIRING

A. The contractor shall adhere to the wiring requirement previously listed.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling

C. Do not install communication wiring in conduits and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrester must be installed between the lines and ground. The lightning arrester shall be installed according to manufacturer's instructions.

G. All runs of communication wiring shall be unspliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
4. An MS/TP EIA-485 network shall have no T connections.

K. All Ethernet cabling, routers, hubs and switches for connecting 230900 furnished and installed control panels, servers and clients to the building owner’s Ethernet network are the responsibility of the BAS contractor.

3.7 FIELD SERVICES

A. Prepare and start logic control system under provisions of this section.
B. Start up and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation. Provide all labor and services as necessary to support testing and verification by third party commissioning authority.
C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for one year or as specified.
D. Provide owner's representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.8 PROJECT RECORD DOCUMENTS

A. Project Record Documents: Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on optical media and as 11” x 17” prints.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Part 3: "Control System Demonstration and Acceptance."
4. As-built versions of submittal product data.
5. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
BUILDING AUTOMATION SYSTEM (BAS) CONTROLS

8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

9. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.

10. Graphic files, programs, and database on magnetic or optical media.

11. List of recommended parts with part numbers and suppliers.

12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.

13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.

14. Licenses, guarantees, and warranty documents for equipment and systems.

15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

3.9 TRAINING

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not be limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of three persons.

C. Provide on-site training above as required, up to 16 hours as part of this contract.

D. Provide tuition for at least one individual to attend for a one-week factory training class. If applicable, costs for travel, lodging and meals will be the responsibility of the owner.

3.10 DEMONSTRATION

A. Demonstrate complete operating system to owner’s representative.

B. Provide certificate stating that control system has been tested and adjusted for proper operation.

END OF SECTION
1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. Furnish complete and operational VFD systems as shown on the plans. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
1. Variable frequency drives (VFDs).
2. Controls and control connections.
3. Electrical power connections.

1.3 RELATED WORK IN OTHER SECTIONS

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230900: Controls and Instrumentation
D. Section 232123: Pumps and Hydronic Specialties
E. Section 233412: Air Handling Equipment
F. Division 26: Coordination of interface items between the Mechanical equipment and controls and the Electrical Work specified in Division 26.

1.4 QUALITY ASSURANCE

A. Supplier of VFD shall be solely responsible for assuring that the VFD shall work properly with the motor(s) being controlled. VFD supplier shall provide all materials and labor required to replace motors, bearing, shafts, etc. that may be incompatible with VFD or become damaged by VFD at no additional cost to the owner. VFD supplier shall reimburse Architect and Engineer at their standard hourly rates for their involvement in resolving failures due to their VFDs.

B. Manufacturer shall have a minimum of 15 years experience building similar equipment for controlling the speed for induction motors and at least one hundred successful installations with a variety of VFD sizes and applications.

C. To insure quality and minimize failures the VFD(s) and connected motor(s) shall be by one manufacturer. To reduce the known problem of bearing failures by "fluting" the VFD switching rates shall be 6-8 Khz wherever possible. Manufactured VFDs at switching rates of 12-15 Khz shall be accompanied by an additional extended warranty to cover bearings and motors to a period of ten (10) years. Should it be impossible to provide matched motor and VFD’s provide a shaft grounding system for the driven motor. Acceptable manufacturer are Shaft Grounding Systems (www.shaft-grounding-systems.com) or Aegis Shaft Grounding Ring (www.est-aegis.com).

D. To insure quality and minimize infantile failures at the job site, the VFD shall be burned in at the factory at an ambient of 104°F minimum for at least 8 hours. The VFD shall be operating a dynamometer and the load speed shall be cycled during the test. All optional and special features shall be functionally tested at the factory for proper operation.

E. Codes and Standards: Provide VFDs conforming to the requirements of the latest addition of the following:
1. ANSI/EIA 508 Electrical Performance Standards for Television Broadcast Transmitters
2. UL508. all VFD equipment provided under this section must be labeled as UL508 approved.

1.5 SUBMITTALS

A. Prior to construction submit for approval the following materials:
   1. VFD supplier shall provide reference list showing at least ten years of prior manufacturing experience in production of VFDs and a list of at least twenty successful installations with a variety of VFD sizes and applications.
   2. Manufacturer’s data, installation instructions, and maintenance and operational instructions for variable frequency drives. Indicate electrical service and special requirements. Include manufacturer’s descriptive literature, repair data, and parts listing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer’s stamp or label affixed.
B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units. Remove damaged equipment from site.

1.7 WARRANTY

A. Provide two-year (24 months) warranty under provisions of Division 01. Provide extended ten (10) year warranty on motors and bearings as described above, if applicable. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB, Reliance, or approved equal by Emerson, Mitsubishi Electric, Square D, Safetronics, Toshiba, Yaskawa, Danfoss-Graham, Trane TR-200, or Allen-Bradley. Connected motors should be by the same manufacturer whenever possible.

2.2 GENERAL

A. Furnish a complete VFD as scheduled on the plans. Refer to plans for locations of variable speed controllers. Each fan or pump motor shall have a dedicated VFD unit. All standard and optional features shall be included within the VFD enclosure unless otherwise specified. The VFD enclosure shall be provided to match the environment requirements where the VFD will be mounted and operated. Provide NEMA rated enclosure as required.

B. The adjustable frequency controller shall convert three-phase, 60 Hz utility power to adjustable voltage and frequency, three-phase, AC power for stepless motor speed control from 10% to 100% of the motor's 60 Hz speed.

C. The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to a DC voltage. Drive shall utilize a single surface mount micro-processor.

D. The VFD shall be of the pulse width modulation (PWM) type. VFDs shall be provided with an advanced flux vector frequency control to limit noise at drive and motor.

E. Drive manufacturer or sales representative shall evaluate electrical system of the project. Any additional protective equipment such as line filters, reactors or input isolation transformers required to prevent interference from drive with other electrical equipment in the building shall be included as part of the bid. No additional expense shall be incurred by Owner for provision or installation of these devices if required for electrical system operation after drive has been purchased. Units shall include factory mounted input line reactors.

F. The VFD maximum output current rating shall be 110% of the motor nameplate full load current. VFD shall be able to start into a rotating load in either direction without trip.
VARIABLE FREQUENCY DRIVES (VFD)

G. The VFD and options shall be tested to ASNI/EIA Standard 508 and listed by a nationally recognized testing agency such as UL or ETL.

H. The VFD and options shall comply with the applicable requirements of the latest standards of ANSI, IEEE, and the National Electrical Code.

I. Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in ANSI/IEEE Standard 519.

J. The drive efficiency shall be 97% (minimum) and have a fundamental power factor of 0.98 at all speeds.

2.3 BASIC FEATURES

A. The VFD shall be housed in a NEMA enclosure appropriate to the mounting location.
   1. NEMA 12 enclosure shall be used for dusty locations, plenum mechanical rooms, penthouses, or air stream mounting.
   2. NEMA 3R is required for all locations exposed to falling rain, snow or ice or to indoor locations subject to falling water.
   3. If NEMA 1 enclosure is suitable it shall be louvered, vented through cabinet using a removable louver/filter, and equipped with an integral cooling fan with thermostat control, and arranged so that units can be mounted back to back on a frame and/or side to side on a wall. Venting fans shall be supplied in enclosure if required. If a different NEMA enclosure is indicated the enclosure shall provide means of maintaining the drive at temperature acceptable to the drive manufacturer in exterior ambient temperatures. Enclosure shall be complete with no requirements for low voltage wiring. Factory mounted main circuit breaker disconnect shall be included.

B. The following operator controls shall be located on the front of the enclosure:
   1. Door mounted operator digital controls consisting of auto/manual switch, start/stop switch with reset and manual speed control. In the auto position, the drive will start/stop from a remote contact closure and motor speed is determined by the follower signal. In the manual position, motor speed is determined by manual speed selection. Manual potentiometers are not acceptable.
   2. Power on pilot light to indicate that the VFD is being supplied by the power line.
   3. Fault digital display to indicate that the VFD has tripped on a fault condition. The drive shall retain in memory the last three (3) fault conditions that caused the drive to trip. Indication should include but not be limited to the following: Under voltage, over voltage, overcurrent, over temperature, phase loss, phase imbalance and external trip.
   4. Digital display to indicate voltage, current, frequency or RPM. Selectable by the operator while the VFD is running.

C. VFD shall be provided with two (2) each form C dry contacts for indication of run and fault starters. In addition each drive shall have an analog output signal 0 to 10 VDC (or 4-20MA) to indicate drive speed (percent of full load).

D. While in the remote mode, the VFD will attempt at least five (5) restarts after a power outage, drive fault or external fault before requiring manual reset. After ten minutes of runtime, the restart attempts return to zero. The VFD shall display a countdown timer when auto restart is being attempted, or incorporate programming to select number of restarts, number of faults per time period, and time between restarts.

2.4 PROTECTIVE FEATURES

A. Protection against input transient voltage spikes.

B. Overload protection for the motor. If power input or output is interrupted while the control is in operation, no damage shall result. The unit shall be able to operate without any equipment connected to the inverter output. The drive must protect itself against all phase-to-phase short circuits and ground faults.
VARIABLE FREQUENCY DRIVES (VFD)

C. Protection against input power undervoltage, overvoltage and phase loss.
D. Protection against output current overload and overcurrent.
E. Protection against over-temperature within the VFD enclosure.
F. Protection against overvoltage on the DC bus.
G. Drive shall have an auxiliary contact to permit a remote trip.
H. DC bus discharge circuit and warning light for protection of service personnel or meet UL requirements for DC bus discharge.
I. Drive shall be capable of operating and insensitive to imbalance or out-of-rotation incoming power phase .
J. Lockable main fused input disconnect shall be factory mounted as specified on the drawings or as required by the application.

2.5 ADJUSTMENTS

A. Maximum speed, adjustable to 100% base speed.
B. Minimum speed, adjustable to 10% base speed.
C. Acceleration time, adjustable 1 to 360 seconds (minimum) factory set at 20 seconds.
D. Deceleration time, adjustable 1 to 360 seconds (minimum) factory set at 20 seconds.
E. Current limit, adjustable 50 to 110%.
F. Adjustable speed lock-outs for three (3) operating ranges.
G. Capable of following 0-5\text{mA}, 4-20\text{mA}, 10-50\text{mA}, 0-4\text{VDC}, 0-8\text{VDC}, 0-10\text{VDC} grounded or ungrounded signal as required to interface with the building control system.

2.6 SERVICE CONDITIONS

A. The VFD shall be designed to operate within the following service conditions:
   1. Ambient temperature, 32°F-104°F.
   2. Relative humidity, 5-95%, non-condensing.
   3. Elevation to 3,300 feet without derating.
   4. AC line voltage variation, -10% to +10% of nominal.

2.7 SPECIAL FEATURES

A. All control wiring, and accessories shall be factory installed in the drive casing so that only the connection of the remote auxiliary start/stop and override contacts is required to provide override control as described above.
B. All drives shall be equipped with fail safety speed control (adjustable 20-100%), factory installed and wired, that operates as follows: If the drive is on (in either normal or override mode) and no signal is detected from the building control system, the drive shall operate at a preset adjustable speed. On resumption of the building control system signal, the drive shall operate as normal. Fail safe speed shall be adjusted through digital keyboard mounted on the outside drive cabinet.
C. Drives shall be protected with input line reactors factory mounted.
D. Provide drive with a communications board enabling it to communicate with the building management system (BMS) over a serial RS-485 interface or with a BACNET, LonWorks, Modbus, Profibus or BMS proprietary interface.

2.8 BYPASS (WHEN SCHEDULED)

A. Provide a manual 3-contactor bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a three position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position the motor is
VARIABLE FREQUENCY DRIVES (VFD)

operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at the full speed from the AC power line and power is disconnected from the VFD so that service can be performed. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation.

B. Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power using a specially designed tool and mechanism while meeting all local and national code requirements for safety.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify that mounting surface is ready to receive work. Mount the VFD(s) on the wall or at supports in locations identified on the drawings. Provide a layout drawing of VFD locations to electrical installer.

B. If the disconnect for the equipment powered by the VFD is in a location where it is probable that it will be placed in an off position prior to shutting down the VFD, the contractor is to provide electrical protection for the VFD. This may be in the form of a conduit and wire interlock between disconnect and drive or internal protection integral to the VFD.

C. Coordinate wiring and control with Control Contractor. Control installers shall install all wiring associated with control signals into the VFD and for interlock control wiring between disconnects and VFDs.

D. Electrical installer shall install all line voltage power wiring and conduit from electrical switchgear and from the VFD to the disconnect at the controlled motor. The only exception to this is when the motor and drive are factory installed on a packaged piece of equipment. In that case the wiring from drive to motor is to be installed in the factory to meet the requirements herein. Coordinate with Division 26 work.

E. Line length between VFD and driven motor shall be as short as possible. Line length shall not exceed twenty (20) feet without prior approval from Engineer.

F. Input and output power wiring shall be installed in separate grounded conduit. In addition, control wiring shall be installed in its own separate grounded conduit.

G. Use symmetric motor cable between the VFD and motor, with low inductance shield or conduit, and with all joints joined with bonding straps. MC metal clad 3 phase type cable per NEC 334-1, UL approved, 3 phase conductors and 3 ground conductors. Sheath to be continuous corrugated aluminum. Manufacturer and type to be BICC 2 kV rated Drives Cable, Anixter series 7V, or approved equal.

H. Use cable connectors with 360 degree connections to the armor conduit at both ends of motor cable. Verify electrical path from inverter cabinet entry plate to armor / conduit to motor terminal box.

I. Install an auxiliary high frequency bonding connection for potential equalization between VFD frame and building steel.

J. Unless absolutely necessary do not install disconnect between VFD and connected motor. VFD is to be furnished with a lockable disconnect.

K. Installation in "Fan Wall " Air Handlers: When a single VFD supplies multiple fans, assemble and prewire units at the factory, installing conduit and conductors between the fan motor, VFD, and terminal strips. Wiring from the VFD output terminals to the fan motor shall be Belden VFD Cable installed in conduit (295XX Series).

3.2 MANUFACTURER’S START-UP SERVICES
VARIABLE FREQUENCY DRIVES (VFD)

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify control wiring, verify power wiring, start-up the drive, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Harmonic test with scope shall be also performed at the job site and results submitted to the Owner's Representative. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

B. Carrier Frequency Set up:
   1. Set initial carrier frequency at 2 kHz.
   2. Manually raise VFD speed output from 10 Hz to 60 Hz by 10 Hz increments, allowing at least 15 seconds between each adjustment. If excessive motor noise is heard at any speed, raise carrier frequency by 2 kHz increments until motor noise is no longer excessive. Do not set carrier frequency higher than 10 kHz.
   3. If excessive motor noise continues to be heard at or below 10 kHz, inform owner. If the motor is provided by the VFD manufacturer, either repair, replace, or provide 5 year extended warranty on the effected motor.

C. Lockout of resonant frequencies:
   1. With carrier frequency set per the above specification, manually and slowly raise VFD speed output from 10 Hz to 60 Hz by 1 Hz increments. If excessive motor, frame, or driven load noise is heard at any speed, lock out that frequency.
   2. Each frequency skip shall be programmed with as narrow a bandwidth as possible, while still avoiding the most objectionable range of resonant frequencies. Each frequency skip bandwidth shall not exceed 5 Hz without approval by Engineer.

D. Training:
   1. Provide 1 hour training session to the owner’s representative.
   2. Training to include
      a. Demonstration of operation of bypass switch and door-mounted disconnect switches. Explain emergency operation.
      b. Demonstrate operation of operator keypads for viewing data and setting parameters.
      c. Demonstrate operation in manual mode, including setting of specific speeds.
      d. Explain the drive parameters that might require operator adjustment.
      e. Describe troubleshooting techniques and warranty procedure.

END OF SECTION
## LEED M&V MASTER MATRIX (POINTS FOR BMS TO MONITOR) - EMU 100% DD

<table>
<thead>
<tr>
<th>ITEM #</th>
<th>EQUIPMENT</th>
<th>ENDUSE</th>
<th>UNIT</th>
<th>METER TYPE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PLUMBING - DIV 22</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLXX</td>
<td>CITY DOMESTIC WATER METER OLD</td>
<td>WATER</td>
<td>GALLONS</td>
<td>UTILITY PROVIDED</td>
<td>The city meter provided by the utility. Verify BMS integration capability provided. Refer to civil drawings for location</td>
</tr>
<tr>
<td>PLXX</td>
<td>CITY DOMESTIC WATER METER NEW</td>
<td>WATER</td>
<td>GALLONS</td>
<td>UTILITY PROVIDED</td>
<td>The city meter provided by the utility. Verify BMS integration capability provided. Refer to civil drawings for location</td>
</tr>
<tr>
<td>PCXX</td>
<td>RETAIL 1</td>
<td>WATER</td>
<td>GALLONS</td>
<td>PULSE</td>
<td>Water usage measure in gallons, total usage measure daily at minimum</td>
</tr>
<tr>
<td>PCXX</td>
<td>RETAIL 2</td>
<td>WATER</td>
<td>GALLONS</td>
<td>PULSE</td>
<td>Water usage measure in gallons, total usage measure daily at minimum</td>
</tr>
<tr>
<td>PCXX</td>
<td>RETAIL 3</td>
<td>WATER</td>
<td>GALLONS</td>
<td>PULSE</td>
<td>Water usage measure in gallons, total usage measure daily at minimum</td>
</tr>
<tr>
<td>PCXX</td>
<td>COFFEE</td>
<td>WATER</td>
<td>GALLONS</td>
<td>PULSE</td>
<td>Water usage measure in gallons, total usage measure daily at minimum</td>
</tr>
<tr>
<td>PCXX</td>
<td>PUB</td>
<td>WATER</td>
<td>GALLONS</td>
<td>PULSE</td>
<td>Water usage measure in gallons, total usage measure daily at minimum</td>
</tr>
<tr>
<td>PGXX</td>
<td>CRAFT CENTER GAS</td>
<td>GAS</td>
<td>BTU</td>
<td>UTILITY PROVIDED</td>
<td>Available from mechanical electrical panel metering device</td>
</tr>
<tr>
<td>PGXX</td>
<td>KITCHEN GAS</td>
<td>GAS</td>
<td>BTU</td>
<td>UTILITY PROVIDED</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>PGXX</td>
<td>BUILDING GAS</td>
<td>GAS</td>
<td>BTU</td>
<td>UTILITY PROVIDED</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>PFXX</td>
<td>STEAM TO HOT WATER RXN</td>
<td>DHW</td>
<td>KBTU/H/KBTU</td>
<td>CADILLAC</td>
<td>KBTU/H recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>PFXX</td>
<td>DHW</td>
<td>DHW</td>
<td></td>
<td></td>
<td>Available from electrical panel metering device</td>
</tr>
<tr>
<td><strong>HVAC - DIV 23</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVXX</td>
<td>HUJ-41</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>HUJ-42</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>HUJ-43</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>HUJ-44</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>HUJ-45</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>HUJ-46</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-11</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-12</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-13</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-14</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-15</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-16</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-17</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-18</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-19</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MUA-20</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MFJ-41</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MFJ-42</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MFJ-43</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MFJ-44</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MFJ-45</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MVXX</td>
<td>MFJ-46</td>
<td>VENTILATION</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>EBP-1</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>EBP-2</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>EBP-3</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>EBP-4</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>CHWS-1</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>CHWS-2</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>CHWS-3</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>CHWS-4</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td>VFD</td>
<td>Verify BMS integration capability with VFD controller card, Instantaneous demand KW recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MFXX</td>
<td>RP-1</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td></td>
<td>Available from electrical panel metering device</td>
</tr>
<tr>
<td>MFXX</td>
<td>RP-2</td>
<td>PUMPS</td>
<td>kW/kWh</td>
<td></td>
<td>Available from electrical panel metering device</td>
</tr>
<tr>
<td>MFXX</td>
<td>CAMPUS CHILLED WATER SW MECH</td>
<td>COOLING</td>
<td>KBTU/H/KBTU</td>
<td>VORTEX</td>
<td>KBTU/H recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MCXX</td>
<td>CAMPUS CHILLED WATER N MECH</td>
<td>COOLING</td>
<td>KBTU/H/KBTU</td>
<td>VORTEX</td>
<td>KBTU/H recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MHXX</td>
<td>CAMPUS STEAM SW ARCH</td>
<td>HEATING</td>
<td>KBTU/H/KBTU</td>
<td>CADILLAC</td>
<td>KBTU/H recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MPHXX</td>
<td>CAMPUS STEAM N ARCH</td>
<td>HEATING</td>
<td>KBTU/H/KBTU</td>
<td>CADILLAC</td>
<td>KBTU/H recorded at 15min intervals and stored for 3 years</td>
</tr>
<tr>
<td>MXXX</td>
<td>YRF R1</td>
<td>COOL/HEAT</td>
<td>kW/kWh</td>
<td></td>
<td>Available from mechanical electrical panel metering device</td>
</tr>
<tr>
<td>MXXX</td>
<td>YRF 21</td>
<td>COOL/HEAT</td>
<td>kW/kWh</td>
<td></td>
<td>Available from mechanical electrical panel metering device</td>
</tr>
<tr>
<td>ELECTRICAL - DIV 26</td>
<td>ELEC</td>
<td>KW/KWH</td>
<td>UTILITY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>--------</td>
<td>---------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETXX PANEL BN2-2 COFFEE SHOP</td>
<td>TENANT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETXX PANEL BN2-2 RETAIL TENANT</td>
<td>TENANT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETXX PANEL 1N2-2 TENANT VENDOR</td>
<td>TENANT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETXX PANEL 1N2-2 TENANT VENDOR</td>
<td>TENANT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETXX PANEL 1N3-2 TENANT VENDOR</td>
<td>TENANT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETXX PANEL 1N4-2 TENANT VENDOR</td>
<td>TENANT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETXX PANEL 1N5-2 TENANT VENDOR</td>
<td>TENANT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX BALLROOM</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL MN2-2, MN1-2</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL 2N2-2 GALLERY CLOSET</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL 2N2-2 GALLERY CLOSET</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL 2N3-2 SOUTH HALL</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN1-2 S WOODSHOP</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN1-2 S WOODSHOP</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN1-2 S CERAMICS</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN1-2 S CERAMICS</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-2 S GLASS</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-2 S GLASS</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-2 S GLASS</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-2 S PLASMA</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-2 S PLASMA</td>
<td>EQUIPMENT</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-4 CRAFT CENTER</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-4 CRAFT CENTER</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-4 CRAFT CENTER</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-4 CRAFT CENTER</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-4 CRAFT CENTER</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-4 CRAFT CENTER</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXXX PANEL BN2-4 CRAFT CENTER</td>
<td>MIX</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECXX STANDBY POWER LOADS</td>
<td>CONTINUOUS</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECXX STANDBY POWER LOADS</td>
<td>CONTINUOUS</td>
<td>KW/KWH</td>
<td>POWER</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 control sequences for HVAC systems, subsystems, and equipment.
B. Related Sections include the following:
   1. Section 230900 "Building Automation System (BAS) Controls " for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS
A. BAS: Building Automation System
B. DDC: Direct digital control.
C. VAV: Variable air volume.

1.4 ABBREVIATIONS
A. The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.
   1. AC - Air Conditioning
   2. ACU - Air Conditioning Unit
   3. AHU - Air Handling Unit
   4. AI - Analog Input
   5. AO - Analog Output
   6. AUTO – Automatic
   7. AUX – Auxiliary
   8. BI - Binary Input
   9. BO - Binary Output
   10. C – Common
   11. CHW - Chilled Water
   12. CHWP - Chilled Water Pump
   13. CHWR - Chilled Water Return
   14. CHWS - Chilled Water Supply
   15. COND – Condenser
   16. CW - Condenser Water
   17. CWP - Condenser Water Pump
   18. CWR - Condenser Water Return
   19. CWS - Condenser Water Supply
   20. DA - Discharge Air
   21. EA - Exhaust Air
   22. EF - Exhaust Fan
   23. EVAP – Evaporators
   24. FCU - Fan Coil Unit
   25. HOA - Hand / Off / Auto
   26. HP - Heat Pump
   27. HRU - Heat Recovery Unit
   28. HTEX - Heat Exchanger
   29. HW - Hot Water
   30. HWP - Heating Water Pump
   31. HWR – Heating Water Return
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

32. HWS - Heating Water Supply
33. MAX – Maximum
34. MIN – Minimum
35. MISC – Miscellaneous
36. NC - Normally Closed
37. NO - Normally Open
38. OA - Outdoor Air
39. RA - Return Air
40. RF - Return Fan
41. RH - Relative Humidity
42. RTU - Roof-top Unit
43. SA - Supply Air
44. SF - Supply Fan
45. SP - Static Pressure
46. TEMP – Temperature
47. UH - Unit Heater
48. UV - Unit Ventilator
49. VAV - Variable Air Volume
50. VVTU - Variable Volume Terminal Unit
51. W/ - with
52. W/O – without
53. WSHP - Water Source Heat Pump

PART 2 - PRODUCTS (NOT APPLICABLE – REFER TO 230900)

PART 3 - EXECUTION

3.1 WINDOW SENSOR & HVAC CONTROL INTEGRATION

A. Window Sensor Control: Manually operable windows in new areas of construction are each to be equipped with a window sensor to provide indication of open/closed status of the window. See zoning plans for sensor locations.

1. For multi-room zones, monitor window sensors. If any window in the zone is open, lock out zone heating and cooling. Close VAV damper and reheat control valve. Remove zone from SA temperature reset algorithm, duct static pressure reset algorithm, chilled water reset algorithm, and heating water reset algorithm. Provide an alarm if space temperature falls below night setback temperature and activate heating. Provide an alarm if space dew point rises above 62deg F.

2. For multi-zone rooms, monitor window sensors. If any window in room is open, lock out zone heating and cooling for all zones in that room. Close VAV dampers and reheat control valves. Remove zone from SA temperature reset algorithm, duct static pressure reset algorithm, chilled water reset algorithm, and heating water reset algorithm. Provide an alarm if space temperature falls below night setback temperature and activate heating. Provide an alarm if space dew point rises above 62deg F.

3. For single-room zones, if windows are open, lockout zone heating and cooling. Close VAV damper and reheat control valve. Remove zone from SA temperature reset algorithm, duct static pressure reset algorithm, chilled water reset algorithm, and heating water reset algorithm. Provide an alarm if space temperature falls below night setback temperature and activate heating. Provide an alarm if space dew point rises above 62deg F.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

3.2 RADIANT FLOOR & DISPLACEMENT VENTILATION

A. First Stage Cooling/Heating will be done by the radiant slab (in both occupied and unoccupied mode); second stage cooling/heating and ventilation will be provided by the displacement ventilation system.

B. Radiant Slab Run Conditions – Scheduled: The radiant system shall run according to a user definable time schedule.
   1. Occupied Mode: The unit shall maintain
      a. A 78°F (adj.) cooling setpoint
      b. A 68°F (adj.) heating setpoint.
   2. Unoccupied Mode (night setback): The unit shall maintain
      a. A 85°F (adj.) cooling setpoint.
      b. A 60°F (adj.) heating setpoint.

C. Interlock radiant re-circ pump with a call for either heating or cooling to the associated zone.
   1. The mixing valve stations shall operate to maintain a return water temperature from the radiant slab in order to satisfy a zone space temperature setpoint (average (2) sensors per zone).
   2. On a call for heating:
      a. The zone re-circ pump will command on.
      b. The 2-position change over valves shall shift to heating mode flow configuration
      c. The zone heating mixing valve shall throttle to maintain the heating return water temperature.
      d. The heating return water setpoint will be reset based on outdoor temperature to avoid overshooting design slab temperature and thus overheating the zone:
         1) <40 deg F (adj.) OSA temperature equates to a 90deg F(adj.) return water setpoint
         2) 50 deg F (adj.) OSA temperature equates to an 85deg F (aj.) return water setpoint.
         3) 60 deg F (adj.) OSA temperature equates to an 80deg F (aj.) return water setpoint.
   3. On a call for cooling:
      a. The zone re-circ pump will command on
      b. The 2-position change over valves shall shift to cooling mode flow configuration
      c. The zone cooling mixing valve shall throttle to maintain the cooling return water temperature.
      d. The heat pump’s return water setpoint will be reset based on space dew point provided via DDC system. (It is acceptable to calculate zone dew point via DDC system with zone relative humidity and temperature sensor input.)
         1) Default return water temperature shall be 65deg F
         2) If Zone dew point + 7deg F (adj.) is greater than return water temperature then reset return water temperature up at 2deg F (adj.) every 5 minutes (adj.) until it equals adjusted zone dew point. Hold this return water temperature for 30 minutes (adj.) and reset return temperature back down at 2deg F (adj.) every 5 minutes (adj.)
         3) If zone dew point + 7deg F (adj.) is greater than return water temperature for 25 minutes (adj.) then turn off radiant system (heat pump and re-circ pump) for 1 hour (adj)
   4. When the zone setpoint is satisfied:
      a. The re-circ pump will command off
      b. The 3-way modulating valves (heating or cooling shall close)
   5. Unoccupied Mode (night setback): Radiant system shall operate similar to occupied mode to maintain new unoccupied zone space setpoints per BMS.

D. Alarms shall be provided as follows:
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. Radiant Supply Water Temperature: If in heating mode; the heating water supplied to the radiant system is greater or less than setpoint by a user definable amount (adj.)
2. Radiant Supply Water Temperature: If in cooling mode; the chilled water supplied to the radiant system is greater or less than setpoint by a user definable amount (adj.)
3. Room Dew Point is above Radiant Supply Water Temperature after 25 minutes (adj.) after attempts to reduce space humidity via the heat pump air handling system have been made. (Radiant system to shut off in this event)
4. Pump Failure: Status does not match command
5. Cycling alarm: Radiant system is experiencing heating/cooling cycles within the same day period (adj.)

E. Radiant slab Optimal Start:
The radiant system shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

F. Radiant slab Zone Unoccupied Override:
A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

G. Displacement Ventilation: The terminal unit supplying air to these zones shall be controlled per “Variable Air Volume Terminal unit – Hot Water Reheat” sequence with exceptions noted below
1. The reheat coil control valve shall modulate to maintain a supply air temperature of 60deg F minimum in cooling mode.

3.3 CHILLED WATER AND HEATING WATER HYDRONIC SYSTEMS (CHILLED BEAMS & PERIMETER HEATING RADIATORS)

A. Tempered Chilled Water Reset Sequence: The 3-way control valve at the radiant chilled water skids shall include a reset sequence based on building humidity levels to avoid condensation accumulation on the chilled water pipes. The chilled water supply temperature setpoint to the building loop shall be be reset when the dewpoint temperature of more than 2 zones are past their dew point temperature setpoint of 55deg F (adjustable). The new the chilled water supply setpoint shall be equal to the highest zone dewpoint temperature + 2°F. When the highest zone dew point point temperature is below the setpoint of 55°F for 15 minutes, the chilled water temperature setpoint will revert back to 58°F. At all times, for any zone that has a dewpoint temperature above the chilled water supply temperature, the zone chilled water control valve shall close and the second stage cooling (air side) shall immediately start to function to maintain the zone temperature setpoint.

B. Hydronic Zone Control Valve Flow Control: The valve shall maintain zone setpoints by controlling the water flow through one of the following:
1. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
2. Occupied:
   a. Cooling Elements Only: When zone temperature is greater than its cooling setpoint, the zone cooling control valve shall modulate open on rising room temperatures.
      i. Active Chilled Beams: hydronic flow will modulate to max flow as first stage cooling. If zone setpoint has not been maintained for 5 minutes (adjustable), modulate vav box damper to provide maximum scheduled airflow to the beams.
   b. Cooling and Heating Elements: When the zone temperature is between the cooling setpoint and the heating setpoint, the zone control valves shall be closed.
   c. Heating Elements Only: When zone temperature is less than its heating setpoint, the zone control valve shall modulate open on lowering room temperatures.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

3. Unoccupied:
   a. Control valves shall function similar to occupied sequence but shall maintain “un-
      occupied temperature setpoints”

3.4 VARIABLE AIR VOLUME TERMINAL UNIT – HOT WATER REHEAT

A. Features
   1. Cooling damper and actuator
   2. Hot water reheat coil
   3. Carbon dioxide monitoring
   4. Humidity monitoring (zones with radiant cooling only)
   5. Secondary Cooling Function (zones with radiant cooling only)
   6. All setpoints shall be user adjustable

B. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule and
   maintain the following modes:
   1. Occupied Mode Temperatures:
      a. Cooling setpoint - 74°F
      b. Heating setpoint - 70°F
   2. Unoccupied Mode Temperatures (night setback):
      a. Cooling setpoint - 85°F
      b. Heating setpoint - 55°F
   3. Four air flow control setpoints shall apply as follows:
      a. Occupied cooling maximum air flow as scheduled
      b. Occupied heating maximum air flow as scheduled
      c. Occupied cooling/heating minimum air flow as scheduled
      d. Unoccupied cooling/heating minimum air flow as scheduled
   4. Alarms shall be provided as follows:
      a. High Zone Temp: If the zone temperature is 5°F greater than the cooling setpoint.
      b. Low Zone Temp: If the zone temperature is 5°F less than the heating setpoint.

C. Minimum Ventilation on Carbon Dioxide (CO2) Concentration (where applicable – see plans):
   When in the occupied mode, the controller shall measure the zone CO2 levels and modulate
   the zone damper open on rising CO2 concentrations, overriding normal damper operation to
   maintain a CO2 setpoint of not more than 600 ppm above ambient outside air CO2 concentra-
   tion.
   1. Alarms shall be provided as follows:
      a. High Zone Carbon Dioxide Concentration: If the zone CO2 concentration is greater
      b. Low Zone Temp: If the zone temperature is 5°F less than the heating setpoint.

D. Zone Dew Point Control on Humidity Levels (only zones with radiant cooling): When in the oc-
   cupied mode and the zone is in cooling, the controller shall measure the zone dew point (direct-
   ly or through calculations based on sensor type) and modulate the zone damper open on rising
   zone dew point, overriding normal damper operation to maintain a dew point of not more than
   55deg F.
   1. Alarms shall be provided as follows:
      a. High Zone Dew Point: If the zone dew point is greater than 60deg F.

E. Air Flow Control: The unit shall maintain zone setpoints by controlling the airflow through one of
   the following:
   1. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating
      and cooling setpoints at the zone sensor.
   2. Occupied:
      a. When zone temperature is greater than its cooling setpoint, the zone damper shall
         modulate between the minimum occupied airflow and the maximum cooling airflow
         until the zone is satisfied. For zones served by radiant cooling products this se-
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. Occupied:
   a. When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation or setpoint determined by dew point control.
   b. When zone temperature is less than its heating setpoint, the controller shall enable heating and modulate the reheat control valve to maintain the zone temperature at its heating setpoint. The zone damper and reheat control valve shall operate in a parallel linear relationship between the minimum occupied airflow and the maximum heating airflow until the zone is satisfied. In zones served by perimeter radiant heating radiators or convectors, the zone damper shall not react to zone temperatures less than heating setpoint.

3. Unoccupied:
   a. When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow.
   b. When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow and the maximum cooling airflow until the zone is satisfied. For zones served by radiant cooling products this sequence shall be a secondary cooling function only. It shall enable if zone setpoint has not been maintained for 5 minutes (adjustable)
   c. When zone temperature is less than its heating setpoint, the controller shall enable heating and modulate the reheat control valve to maintain the zone temperature at its heating setpoint. The zone damper and reheat control valve shall operate in a parallel linear relationship between the minimum occupied airflow and the maximum heating airflow until the zone is satisfied. In zones served by perimeter radiant heating radiators or convectors, the zone damper shall not react to zone temperatures less than heating setpoint.

F. Reheat Coil Control Valve: The controller shall measure the zone temperature and modulate the reheat coil valve open on dropping temperature to maintain its heating setpoint. In zones served by perimeter radiant heating radiators or convectors, the reheat coil valve shall modulate to deliver "room neutral" air when the zone is in heating mode. The reheat coil control valve shall fail in the last position (non-spring return).

G. Reheating - High Discharge Air Temperature Limit: The controller shall measure the discharge air temperature and limit reheating if the discharge air temperature is more than 25°F above the zone temperature.

H. Perimeter Heating Coil Valve: The controller shall measure the zone temperature and modulate the perimeter heating coil valve open on dropping temperature to maintain its heating setpoint.

I. Discharge Air Temperature: The controller shall monitor the discharge air temperature.
   1. Alarms shall be provided as follows:
      a. High Discharge Air Temperature: If the discharge air temperature is greater than 120°F.
      b. Low Discharge Air Temperature: If the discharge air temperature is less than 40°F.

J. Occupancy Sensor Operation (where applicable – see plans):
   1. Occupancy sensors shall override building schedule
   2. When space is occupied the terminal unit control sequence shall function as previously stated for the occupied mode.
   3. When space is unoccupied the terminal unit control sequence shall function as previously stated for unoccupied mode.

K. Environmental Index: When the zone is occupied, the controller will monitor the deviation of the zone temperature from the heating or cooling setpoint. The controller will also monitor the car-
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

bon dioxide level and compare it to comfort conditions. This data will be used to calculate a 0 - 100% Environmental Index which gives an indication of how well the zone is maintaining comfort. The controller will also calculate the percentage of time since occupancy began that the Environmental Index is 70% or higher. Optionally, a weighting factor can be configured to adjust the contribution of the zone to the rollup average index based upon the floor area of the zone, importance of the zone, or other static criteria.

L. Terminal units in 4th floor penthouse associated with AHU 4-1 have (E) pressure dependant pneumatic motorized dampers downstream of them. Mechanical contractor shall locate all damper assemblies and replace damper. (E) damper locations are partially shown on the DM plans. Control contractor shall replace actuator with modern DDC actuator. The motorized dampers shall open or close based on room occupancy. BMS shall monitor damper position and recalculate associated terminal unit airflow setpoint as required to avoid over conditioning the spaces when specific motorized dampers are closed. A single well located thermostat shall be provided to control the pressure independent terminal unit in the penthouse.

3.5 VARIABLE AIR VOLUME DEDICATED OUTSIDE AIR UNITS - CHILLED AND HEATING WATER

A. Features

1. Chilled water coil
2. Heating water coil
3. Heat Recovery coil
4. Supply/Outside fan air flow monitoring
5. Exhaust fan air flow monitoring
6. Air economizer
7. Humidity monitoring
8. Trim and respond static air pressure reset
9. Trim and respond supply air temperature reset
10. All setpoints shall be user adjustable

B. Run Conditions - Requested:

1. The unit shall run whenever:
   a. Any zone is occupied.
   b. Or, a definable number of unoccupied zones need heating or cooling.

C. Alarms shall be provided as follows:

1. Supply Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
2. Return Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a return air smoke detector status. Note to Editor – delete if not required by state law or individual floors/areas do not exceed 15,000 cfm. Not required in California. See NFPA 90A – 6.4.2.1
3. High Static Shutdown: The unit shall shut down and generate an alarm upon receiving a high static shutdown signal. The fans shall be shut down through a duct static pressure high limit switch. The switch shall be set to trip at a pressure that is 20% greater than the maximum design working pressure or 75% of the supply duct SMACNA pressure rating, whichever is greater.
4. Freeze Protection: The unit shall shut down and generate an alarm upon receiving a freezestat status. Note to Editor – not required in some southern climate zones. Revise sequence and control details as necessary.

D. AHU Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.

E. Supply Fan: The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties.

SERA Architects Inc. Packages 2,3,4 & 5- 100% Design Development

NOTICE OF ALTERNATE BILLING CYCLE: The Contract will allow the Owner to require the submission of billings or estimates in billing cycles other than 30-day cycles. Billing or statements shall be submitted monthly ending on the last day of the month.

NOTICE OF EXTENDED CERTIFICATION PROVISION: The Contract will allow the Owner to certify billings and estimate within 20 days after the billings and estimates are received from the original contractor.

NOTICE OF EXTENDED PAYMENT PROVISION: The Contract will allow the Owner to make payment within 30 days after the date a billing or estimate is received.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. Alarms shall be provided as follows:
   a. Supply Fan Failure: Commanded on, but the status is off.
   b. Supply Fan in Hand: Commanded off, but the status is on.
   c. Supply Fan VFD Fault.

F. Supply Air Duct Static Pressure Control: The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint as follows:
   1. The base duct static pressure setpoint shall be set to 1.5 inches H2O. Note to Editor – modify initial duct static setpoint depending on design requirements. Initial setpoint may need to be adjusted during test and balance.
   2. As ventilation/cooling demand increases, the setpoint shall incrementally reset up to a maximum of 0.5 inches H2O above the base static pressure setpoint.
   3. As ventilation/cooling demand decreases, the setpoint shall incrementally reset down to a minimum of 0.25 inches H2O below the base static pressure setpoint.
   4. The fan VFD speed(s) shall not drop below 15 hz, or as recommended by manufacturer.
   5. Alarms shall be provided as follows:
      a. High Supply Air Static Pressure: If the supply air static pressure is 1.0 inches H2O greater than setpoint.
      b. Low Supply Air Static Pressure: If the supply air static pressure drops to 0.5 inches H2O.

G. Exhaust Fan: The return fan shall run whenever the supply fan runs.
   1. Alarms shall be provided as follows:
      a. Return Fan Failure: Commanded on, but the status is off.
      b. Return Fan in Hand: Commanded off, but the status is on.
      c. Return Fan VFD Fault.

H. Exhaust Fan Speed Control: The controller shall modulate the exhaust fan speed by:
   1. The supply fan VFD signal shall be utilized for the primary control loop to determine the cfm setpoint of the exhaust fans sensed by the VFD speed signal. The cfm setpoint shall be used to establish a linear relationship from the signal established during the air balance based on the maximum measured supply cfm less any cfm required to maintain the building at +0.02” wc. (see “Building Static Pressure Control” below for sensor location)
   2. The fan VFD speed(s) shall not drop below 15 hz, or as recommended by manufacturer.
   3. Alarms shall be provided as follows:
      a. High Return Air Static Pressure: If the return air static pressure is 1.0 inches H2O greater than setpoint.
      b. Low Return Air Static Pressure: If the return air static pressure drops to 0.25 inches H2O.

I. Building Static Pressure Control: The controller shall measure building static pressure and modulate the Exhaust Fan as required to maintain building static pressure at the main entrance doors of +0.02” wc with a range of +0.01” wc minimum to +0.08” wc maximum
   1. Alarms shall be provided as follows:
      a. High Building Static Pressure: If the building air static pressure exceeds +0.10” H2O.
      b. Low Building Static Pressure: If the building air static pressure is less than 0.0” H2O.

J. Supply Air Temperature Setpoint - Optimized: The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone dehumidification and second stage cooling requirements. All zone dew point setpoints shall be set default at 55deg F but shall be adjustable per zone at the BMS. The BMS shall track secondary stage cooling requirements separately from first stage cooling requirements. Second stage cooling shall be initiated anytime a zone is above its cooling setpoint for a time greater than 5 minutes. (First stage cooling is provided by passive chilled elements)
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. During non-economizer hours the supply air temperature setpoint shall be reset for dehumidification and second stage cooling requirements as follows:
   a. The initial supply air temperature setpoint shall be 55\(^\circ\)F.
   b. As dehumidification or second stage cooling demand increases, the setpoint shall incrementally reset down to a minimum of 52\(^\circ\)F.
   c. As dehumidification or second stage cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72\(^\circ\)F.

K. Cooling Coil Valve:

1. The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint. The cooling control valve shall modulate slowly to limit supply temperature change to no more than 1\(^\circ\)F in a two minute period.

2. The cooling shall be enabled whenever:
   a. The economizer mode (if present) is disabled and the outside air temperature is not sufficient to meet the dehumidification demands.
   b. The economizer mode (if present) is disabled and the outside air temperature is not sufficient to meet the second stage cooling demands.
   c. AND the supply fan status is on.

3. The cooling coil valve shall open to 50% whenever the freezestat is enabled.

4. Alarms shall be provided as follows:
   a. High Supply Air Temperature: If the supply air temperature is 5\(^\circ\)F greater than setpoint.
   b. Low Supply Air Temperature: If the supply air temperature is below 40\(^\circ\)F.

L. Heating Coil Valve:

1. When the associated zones are primarily in heating mode, this coil shall maintain a minimum supply air temperature of 55\(^\circ\)F with the terminal unit reheat coils further heating the air to a neutral 70deg F. This shall provide internal zones with second stage cooling requirements with adequate cooling capacity at all times of the year. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint. The heating control valve shall modulate slowly to limit supply temperature change to no more than 1\(^\circ\)F in a two minute period.

2. The heating shall be enabled whenever:
   a. Outside air temperature is less than 55\(^\circ\)F.
   b. AND the supply fan status is on.
   c. AND the cooling is not active.

3. The heating coil valve shall open whenever:
   a. Supply air temperature drops to 35\(^\circ\)F.
   b. OR the freezestat is enabled.

4. Alarms shall be provided as follows:
   a. Low Supply Air Temperature: If the supply air temperature is 5\(^\circ\)F less than setpoint.

M. Economizer: When outdoor air conditions allow and the building is primarily in cooling mode (70% of zones are in cooling mode), the economizer shall function as first stage cooling for the building in lieu of the chilled elements. Zone level terminal units shall modulate airflow above ventilation minimum requirements to maintain room temperature setpoints. Chilled elements shall function as second stage cooling during these times. The economizer dampers shall include an OSA bypass damper around the heat pipe to eliminate heat exchange during economizer hours.

1. The economizer shall be enabled whenever:
   a. Outside air temperature is less than 70\(^\circ\)F.
   b. AND outside air dewpoint is less than 53\(^\circ\)F.
   c. AND the supply fan status is on.

2. The economizer shall disable whenever:
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

a. Outside air temperature drops below the supply air temperature required to meet the cooling demand.
b. OR outside air dewpoint rises above 53°F
c. OR high dew point alarm registers in more than 2 zones
d. OR the freezestat (if present) is energized.
e. OR on loss of supply fan status.

N. The outside and exhaust air dampers shall close when the unit is off.

O. Warming Warm Up: A bypass damper shall be provided that bypasses the heat pipe and allow for 100% recirculation of building return air. This damper shall be closed at all times except during morning warm up in which case it shall be fully open with exhaust and outside air dampers fully closed. The supply fan shall run at the maximum airflow setpoint with the heating control valve modulating to maintain the morning warm up supply air temperature setpoint. The morning warm up start time and duration shall be terminated by the controls contractor and programmed based on outside air temperature and building temperature.

P. Energy Recovery – A passive heat pipe (no direct control) shall provide heat recovery performance as scheduled on the mechanical plans.

1. Cooling Recovery Mode: The run-around loop pump shall run continuously. The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F less than the unit supply air temperature setpoint. The run-around loop shall run for cool recovery whenever:

2. Heating Recovery Mode: The run-around loop pump shall run continuously. The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F greater than the unit supply air temperature setpoint. The run-around loop shall run for heat recovery whenever:

3. Frost Protection: The run-around loop pump shall run and the run-around loop mixing valve shall close to 0% in order to circulate water through the run-around loop exhaust air coil whenever:

4. Alarms shall be provided as follows:

Q. Pre-occupancy: The air handler shall be energized a minimum of one hour prior to scheduled occupied period to provide design minimum ventilation air throughout the building as determined by the ventilation airflow setpoint on the mechanical terminal unit schedule. Temperature control may continue to function per the un-occupied schedule.

R. Prefilter Differential Pressure Monitor: The controller shall monitor the differential pressure across the prefILTER.

1. Alarms shall be provided as follows:
   a. Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit initially set to 0.5” wg above clean filter differential static pressure.

E. Final Filter Differential Pressure Monitor: The controller shall monitor the differential pressure across the final filter.

1. Alarms shall be provided as follows:
   a. Final Filter Change Required: Final filter differential pressure exceeds a user definable limit initially set to 1.0” wg above the clean filter differential static pressure.

T. Supply Air Temperature: The controller shall monitor the supply air temperature and use as required for programming.

1. Alarms shall be provided as follows:
   a. High Supply Air Temperature: If the supply air temperature is greater than 90°F.
   b. Low Supply Air Temperature: If the supply air temperature is less than 40°F.

U. Exhaust Air Temperature (post HX): The controller shall monitor the exhaust air temperature and use as required for programming.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. Alarms shall be provided as follows:
   a. High Exhaust Air Temperature: If the exhaust air temperature is greater than 100°F.
   b. Low Exhaust Air Temperature: If the exhaust air temperature is less than 35°F.

V. Return Air Temperature (pre HX): The controller shall monitor the return air temperature.

1. Alarms shall be provided as follows:
   a. High Return Air Temperature: If the return air temperature is greater than 85°F.
   b. Low Return Air Temperature: If the return air temperature is less than 45°F.

3.6 VARIABLE AIR VOLUME AIR HANDLING UNIT – CHILLED AND HEATING WATER - SCOPE INCLUDES BOTH (N) AND (E) UNITS TO BE RETROFITTED

A. Features
   1. Chilled water coil
   2. Heating water coil for preheat
   3. Supply fan air flow monitoring
   4. Return fan air flow monitoring
   5. Outside air flow monitoring
   6. Air economizer
   7. Trim and respond static air pressure reset
   8. Trim and respond supply air temperature reset
   9. All setpoints shall be user adjustable

B. Run Conditions - Requested:
   1. The unit shall run whenever:
      a. Any zone is occupied.
      b. Or, a definable number of unoccupied zones need heating or cooling.

C. Alarms shall be provided as follows:
   1. Supply Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
   2. Return Air Smoke Detection: The unit shall shut down and generate an alarm upon receiving a return air smoke detector status. Note to Editor – delete if not required by state law or individual floors/areas do not exceed 15,000 cfm. Not required in California. See NFPA 90A – 6.4.2.1
   3. High Static Shutdown: The unit shall shut down and generate an alarm upon receiving a high static shutdown signal. The fans shall be shut down through a duct static pressure high limit switch. The switch shall be set to trip at a pressure that is 20% greater than the maximum design working pressure or 75% of the supply duct SMACNA pressure rating, whichever is greater.
   4. Freeze Protection: The unit shall shut down and generate an alarm upon receiving a freezestat status. Note to Editor – not required in some southern climate zones. Revise sequence and control details as necessary.

D. AHU Optimal Start: The unit shall start prior to scheduled occupancy based on the time necessary for the zones to reach their occupied setpoints. The start time shall automatically adjust based on changes in outside air temperature and zone temperatures.

E. Supply Fan: The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties.
   1. Alarms shall be provided as follows:
      a. Supply Fan Failure: Commanded on, but the status is off.
      b. Supply Fan in Hand: Commanded off, but the status is on.
      c. Supply Fan VFD Fault.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

F. Supply Air Duct Static Pressure Control: The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint as follows:
1. The base duct static pressure setpoint shall be set to 1.5 inches H2O. Note to Editor – modify initial duct static setpoint depending on design requirements. Initial setpoint may need to be adjusted during test and balance.
2. As cooling demand increases, the setpoint shall incrementally reset up to a maximum of 0.5 inches H2O above the base static pressure setpoint.
3. As cooling demand decreases, the setpoint shall incrementally reset down to a minimum of 0.25 inches H2O below the base static pressure setpoint.
4. The fan VFD speed(s) shall not drop below 15 hz, or as recommended by manufacturer.
5. Alarms shall be provided as follows:
   a. High Supply Air Static Pressure: If the supply air static pressure is 1.0 inches H2O greater than setpoint.
   b. Low Supply Air Static Pressure: If the supply air static pressure drops to 0.5 inches H2O.

G. Return Fan: The return fan shall run whenever the supply fan runs.
1. Alarms shall be provided as follows:
   a. Return Fan Failure: Commanded on, but the status is off.
   b. Return Fan in Hand: Commanded off, but the status is on.
   c. Return Fan VFD Fault.

H. Return Fan Speed Control: The controller shall modulate the return fan speed by the greater of the two following control loops:
1. The supply fan VFD signal shall be utilized for the primary control loop to determine the cfm setpoint of the return fans sensed by the VFD speed signal. The cfm setpoint shall be used to establish a linear relationship from the signal established during the air balance based on the maximum measured supply cfm less any cfm required to maintain the building at +0.02" wc, and.
2. The secondary control loop shall be based on maintaining a positive pressure in the exhaust air plenum by modulating the exhaust air dampers to maintain an exhaust plenum pressure of +0.02" wc minimum to 0.07" wc maximum.
3. The fan VFD speed(s) shall not drop below 15 hz, or as recommended by manufacturer.
4. Alarms shall be provided as follows:
   a. High Return Air Static Pressure: If the return air static pressure is 1.0 inches H2O greater than setpoint.
   b. Low Return Air Static Pressure: If the return air static pressure drops to 0.25 inches H2O.

I. Building Static Pressure Control: The controller shall measure building static pressure and modulate the exhaust air dampers as required to maintain building static pressure at the main entrance doors of +0.02" wc with a range of +0.01" wc minimum to +0.08" wc maximum
1. Alarms shall be provided as follows:
   a. High Building Static Pressure: If the building air static pressure exceeds +0.10" H2O.
   b. Low Building Static Pressure: If the building air static pressure is less than 0.0" H2O.

J. Supply Air Temperature Setpoint - Optimized: The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling requirements.
1. The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:
   a. The initial supply air temperature setpoint shall be 55°F.
   b. As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F.
K. Cooling Coil Valve:
   1. The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint. The cooling control valve shall modulate slowly to limit supply temperature change to no more than 1°F in a two minute period.
   2. The cooling shall be enabled whenever:
      a. The economizer mode (if present) is disabled and the outside air temperature is not sufficient to meet the cooling demands.
      b. AND the supply fan status is on.
   3. In freezing climates the cooling coil valve shall open to 50% whenever the freezestat (if present) is enabled.
   4. Alarms shall be provided as follows:
      a. High Supply Air Temperature: If the supply air temperature is 5°F greater than setpoint.
      b. Low Supply Air Temperature: If the supply air temperature is below 40°F.

L. Heating Coil Valve:
   1. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint. The heating control valve shall modulate slowly to limit supply temperature change to no more than 1°F in a two minute period.
   2. The heating shall be enabled whenever:
      a. Outside air temperature is less than 65°F.
      b. AND the supply fan status is on.
      c. AND the cooling (if present) is not active.
   3. The heating coil valve shall open whenever:
      a. Supply air temperature drops to 35°F.
      b. OR the freezestat (if present) is enabled and heating coil is upstream of cooling coil.
   4. Alarms shall be provided as follows:
      a. Low Supply Air Temperature: If the supply air temperature is 5°F less than setpoint.

M. Economizer: The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position per design and as determined by the test and balance contractor whenever occupied.
   1. The economizer shall be enabled whenever:
      a. Outside air temperature is less than 69°F or maximum temperature as allowed by local energy code.
      b. AND the outside air temperature is less than the return air temperature.
      c. AND the supply fan status is on.
   2. The economizer shall close whenever:
      a. Mixed air temperature drops below the supply air temperature required to meet the cooling demand.
      b. OR the freezestat (if present) is energized.
      c. OR on loss of supply fan status.

N. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

O. Minimum Outside Air Ventilation: When in the occupied mode, the controller shall measure the outside airflow and modulate the outside air dampers to maintain the proper minimum outside air ventilation, overriding normal damper control. On dropping outside airflow, the controller shall modulate the outside air dampers open to maintain the outside airflow setpoint.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

P. Minimum Outside Air Ventilation - Carbon Dioxide (CO2) Control: When in the occupied mode, the controller shall monitor zone CO2 levels served by this air handling unit. The controller shall take the highest zone CO2 level and modulate the outside air damper(s) open on rising CO2 concentrations, overriding normal damper operation to maintain a CO2 setpoint of 600 ppm above ambient outdoor CO2 level.

1. Alarms shall be provided as follows:
   a. High Zone Carbon Dioxide Concentration: If the highest zone CO2 concentration is greater than 1000 ppm.

2. Cooling Recovery Mode: The run-around loop pump shall run continuously. The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F less than the unit supply air temperature setpoint. The run-around loop shall run for cool recovery whenever:

3. Heating Recovery Mode: The run-around loop pump shall run continuously. The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F greater than the unit supply air temperature setpoint. The run-around loop shall run for heat recovery whenever:

4. Frost Protection: The run-around loop pump shall run and the run-around loop mixing valve shall close to 0% in order to circulate water through the run-around loop exhaust air coil whenever:

Q. Pre-occupancy: The air handler shall be energized a minimum of one hour prior to scheduled occupied period to circulate design minimum ventilation air throughout the building or a minimum of three complete air changes, whichever is less. Temperature control may continue to function per the un-occupied schedule.

R. Prefilter Differential Pressure Monitor: The controller shall monitor the differential pressure across the prefilter.

1. Alarms shall be provided as follows:
   a. Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit initially set to 0.5" wg above clean filter differential static pressure.

Final Filter Differential Pressure Monitor: The controller shall monitor the differential pressure across the final filter.

1. Alarms shall be provided as follows:
   a. Final Filter Change Required: Final filter differential pressure exceeds a user definable limit initially set to 1.0" wg above the clean filter differential static pressure.

T. Mixed Air Temperature: The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).

1. Alarms shall be provided as follows:
   a. High Mixed Air Temperature: If the mixed air temperature is greater than 90°F.
   b. Low Mixed Air Temperature: If the mixed air temperature is less than 40°F.

U. Return Air Humidity: The controller shall monitor the return air humidity and use as required for secondary economizer control (if present).

1. Alarms shall be provided as follows:
   a. High Return Air Humidity: If the return air humidity is greater than 70% rh.
   b. Low Return Air Humidity: If the return air humidity is less than 35% rh.

V. Return Air Temperature: The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).

1. Alarms shall be provided as follows:
   a. High Return Air Temperature: If the return air temperature is greater than 90°F.
   b. Low Return Air Temperature: If the return air temperature is less than 45°F.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

W. Supply Air Temperature: The controller shall monitor the supply air temperature.
   1. Alarms shall be provided as follows:
      a. High Supply Air Temperature: If the supply air temperature is greater than 120°F.
      b. Low Supply Air Temperature: If the supply air temperature is less than 45°F.

X. Provide all controls scope (software and hardware) necessary to retrofit AHU G-1 and AHU G-2
to accommodate the sequence indicated in this section.

3.7 SINGLE ZONE PACKAGED UNIT – GAS HEATING AND DX COOLING

A. Features
   1. Single package unitary unit
   2. Direct expansion cooling with compressor(s)
   3. Natural gas furnace heating
   4. Air economizer with dampers and actuators
   5. Powered exhaust fan for economizer relief
   6. Carbon dioxide monitoring
   7. Integral manufacturer controller
   8. All setpoints shall be user adjustable

B. Run Conditions – Scheduled:
   1. The unit shall run according to a user definable time schedule in the following modes:
   2. Occupied Mode Temperatures:
      a. Cooling setpoint - 75°F cooling setpoint to maintain 5°F deadband above heating
         setpoint
      b. Heating setpoint - 70°F
   3. Unoccupied Mode Temperatures (night setback):
      a. Cooling setpoint - 85°F cooling setpoint for climate regions where the summer de-
         sign dry bulb 0.5 percent temperatures is greater than 100°.
      b. Heating setpoint - 55°F
   4. Standby Mode Temperatures (after morning warmup and prior to occupancy sensed):
      (Verify if applicable. Only applicable if you have occupancy sensor control and optimum
      start capability. This is primarily a California issue, but should be considered on all pro-
      jects.)
      a. Cooling setpoint - 78°F
      b. Heating setpoint - 66°F
   5. Zone Unoccupied Override:
      a. A timed local override control shall allow an occupant to override the schedule and
         place the unit into an occupied mode for 4 hours. At the expiration of this time, 
         control of the unit shall automatically return to the schedule.
   6. Zone Setpoint Adjustment:
      a. The occupant shall be able to adjust the zone temperature heating and cooling
         setpoints at the zone sensor.
   7. Alarms shall be provided as follows:
      a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by
         5°F.
      b. Low Zone Temp: If the zone temperature is less than the heating setpoint by 5°F.

C. Emergency Shutdown:
   1. The unit shall shut down and generate an alarm upon receiving an emergency shutdown
      signal.
   2. Supply Air Smoke Detection:
      a. The unit shall shut down and generate an alarm upon receiving a supply air smoke
         detector status.

D. Supply Fan:
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. The supply fan shall run continuously during occupied periods, unless shutdown on safety. To prevent short cycling, the supply fan shall have a user definable minimum runtime.

2. Alarms shall be provided as follows:
   a. Supply Fan Failure: Commanded on, but the status is off.
   b. Supply Fan in Hand: Commanded off, but the status is on.
   c. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit.

E. Cooling:
   1. The controller shall measure the zone temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, there shall be a user definable delay between stages, and each stage shall have a user definable minimum runtime.
   2. The cooling shall be enabled whenever:
      a. There is a call for cooling.
      b. AND the economizer is disabled or fully open.
      c. AND the zone temperature is above cooling setpoint.
      d. AND the supply fan status is on.
      e. AND the heating is not active.

F. Heating
   1. The controller shall measure the zone temperature and stage the heating to maintain its heating setpoint. To prevent short cycling, there shall be a user definable delay between stages, and each stage shall have a user definable minimum runtime.
   2. The heating shall be enabled whenever:
      a. There is a call for heating.
      b. AND the zone temperature is below heating setpoint.
      c. AND the supply fan status is on.
      d. AND the cooling is not active.

G. Mixed Air Temperature:
   1. The controller shall monitor the mixed air temperature and use as required for economizer control.
   2. Alarms shall be provided as follows:
      a. High Mixed Air Temp: If the mixed air temperature is greater than 90°F.
      b. Low Mixed Air Temp: If the mixed air temperature is less than 45°F.

H. Return Air Temperature:
   1. The controller shall monitor the return air temperature and use as required for economizer control.
   2. Alarms shall be provided as follows:
      a. High Return Air Temp: If the return air temperature is greater than 90°F.
      b. Low Return Air Temp: If the return air temperature is less than 45°F.

Air Economizer (Dry bulb):
   1. The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position of whenever occupied to meet minimum required ventilation rate.
   2. The economizer shall be enabled whenever:
      a. Outside air temperature is less than 70°F.
      b. AND the outside air temperature is less than the return air temperature.
      c. AND the supply fan status is on.
   3. The economizer shall close whenever:
      a. Mixed air temperature drops from 45°F to 40°F.
      b. OR on loss of supply fan status.
      c. OR the freezeastat is on.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

4. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off.

J. Power Exhaust Fan Control:
1. The controller shall measure building static pressure and modulate the economizer exhaust air dampers and enable the power exhaust fan as required to maintain building static pressure at the main entrance doors of +0.02” wc with a range of +0.01” wc minimum to +0.08” wc maximum
2. Alarms shall be provided as follows:
   a. High Building Static Pressure: If the building air static pressure exceeds +0.10” H2O.
   b. Low Building Static Pressure: If the building air static pressure is less than 0.0” H2O.

K. Carbon Dioxide (CO2) Control:
1. The controller shall measure the zone CO2 level and outdoor ambient CO2 level.
2. When in the occupied mode, the controller shall measure the zone CO2 levels and modulate the outside air dampers open on rising CO2 concentrations, overriding normal damper operation to maintain a CO2 setpoint no greater than outside ambient CO2 concentration plus 600 ppm (approximately 1,000 ppm).
3. The mixed air temperature shall not exceed 80⁰F when in CO2 control.
4. Alarms shall be provided as follows:
   a. High Zone Carbon Dioxide Concentration: If the zone air CO2 concentration is greater than 1000ppm when in the occupied mode.

L. Occupancy Sensor Operation (where equipped):
1. When space is occupied the terminal unit control sequence shall function as previously stated for the occupied mode.
2. When space is unoccupied the terminal unit control sequence shall function as previously stated for unoccupied mode.

M. Economizer Fault Detection and Diagnostics (FDD)
1. FDD is required to on all air-cooled unitary direct-expansion units with AHRI capacity greater than 54,000 Btuh and equipped with air economizer.
2. The FDD controller shall have a visual display with input and output capability.
3. Temperature sensors shall monitor:
   a. Outside air temperature
   b. Supply air temperature
   c. Return air temperature
4. Controller shall provide status for:
   a. Free cooling availability
   b. Economizer enabled
   c. Compressor enabled
   d. Heating enabled
   e. Mixed air low limit cycle active
5. Controller shall be capable of manually initiating the following modes for independent testing and verification:
   a. Compressor operation
   b. Economizers
   c. Fans
   d. Heating system
6. Faults shall be annunciated locally at zone thermostats or at building automation system.
   a. Temperature sensors shall

N. Occupant Controlled Smart Thermostats (OCST) OCST shall include capabilities to enable remote Demand Responsive Control through receipt of Demand Response Signals or price signals. The OCST shall be capable of receiving and responding to Demand Respond
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

Signals for two modes: price responses and demand response periods. Both event modes can be overridden by the occupant or by the building automation system.

2. The OCST shall be provided with a switch or interface to enable or disable onboard communications by the occupant. When disabled the thermostat shall function as a programmable setback thermostat.

3. OCST display and interface features shall include:
   a. Communications system connection status
   b. Indication that a Demand Response Period or pricing event is in progress
   c. Maintenance related information
   d. Current sensed temperatures
   e. Current setpoint

4. Demand Response Control:
   a. Upon receiving a price signal or Demand Response Signal the OCST shall be capable of automatic event response by adjusting the currently applicable temperatures setpoints.
   b. When the price signal changes to a non-response level or Demand Response Period is concluded, the OCST shall return all thermostat functions to normal operation.
   c. Default occupied cooling mode setpoint: 82°F
   d. Default occupied heating mode setpoint: 60°F
   e. Maximum remote cooling setpoint: 90°F
   f. Minimum remote heating setpoint: 50°F
   g. Occupant shall be able to override or change setpoints during all control periods.

3.8 EXHAUST FAN - BUILDING STATIC

A. Run Conditions - Interlocked: The exhaust fan unit shall be interlocked to run whenever the air handling unit runs unless shutdown on safeties.

B. Control – Building Static Pressure: The exhaust fan shall run when commanded on. The controller shall measure building static pressure and modulate the exhaust fan VFD speed to maintain a building static pressure setpoint of 0.05” w.g. (adjustable). The exhaust fan VFD speed shall not drop below 20% (adjustable).
   1. Alarms shall be provided as follows:
      a. High Building Static Pressure: If the building static pressure is 25% (adjustable) greater than setpoint.
      b. Low Building Static Pressure: If the building static pressure is 25% (adjustable) less than setpoint.
      c. Exhaust Fan VFD Fault.

C. Exhaust Air Damper: The exhaust air damper shall open anytime the unit runs and shall close anytime the unit stops. The exhaust air damper shall close 30 seconds (adjustable) after the fan stops.

D. Damper Status: The fan shall be enabled after the damper status has proven.
   1. Alarms shall be provided as follows:
      a. Damper Failure: Commanded open, but the status is closed.
      b. Damper in Hand: Commanded closed, but the status is open.

E. Fan Status: The controller shall monitor the fan status.
   1. Alarms shall be provided as follows:
      a. Fan Failure: Commanded on, but the status is off.
      b. Fan in Hand: Commanded off, but the status is on.

3.9 EXHAUST FAN - ON/OFF

A. Run Conditions - Interlocked: The fan(s) shall be interlocked to run whenever the air handling unit runs unless shutdown on safeties.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

B. Fan Status: The controller shall monitor the fan status.
   1. Alarms shall be provided as follows:
      a. Fan Failure: Commanded on, but the status is off.
      b. Fan in Hand: Commanded off, but the status is on.

3.10 CABINET HEATER

A. Run Conditions - Scheduled:
   1. The unit shall run according to a user definable time schedule in the following modes:
      a. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adjustable).
      b. Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F (adjustable).
   4. Alarms shall be provided as follows:
      a. Low Zone Temperature: If the zone temperature is less than the heating setpoint by a user definable amount (adjustable).

B. Demand Limiting - Zone Setpoint Optimization: To lower power consumption, the zone setpoints shall automatically relax when the facility power consumption exceeds definable thresholds. The amount of relaxation shall be individually configurable for each zone. The zone setpoints shall automatically return to their previous settings when the facility power consumption drops below the threshold.
   1. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
   2. Zone Optimal Start: The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
   3. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

C. Fan: The fan shall run anytime the zone temperature is below heating setpoint, unless shutdown on safeties.

D. Heating Coil Valve: The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.

E. The heating shall be enabled whenever:
   1. Outside air temperature is less than 65°F (adjustable).
   2. AND the zone temperature is below heating setpoint.
   3. AND the fan is on.

3.11 UNIT HEATER

A. Run Conditions - Scheduled:
   1. The unit shall run according to a user definable time schedule in the following modes:
      a. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adjustable).
      b. Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F (adjustable).
   2. Alarms shall be provided as follows:
      a. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adjustable).
   3. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
   4. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

5. Fan: The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.

B. Heating Coil Valve: The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
   1. The heating shall be enabled whenever:
      a. Outside air temperature is less than 65°F (adjustable).
      b. AND the zone temperature is below heating setpoint.
      c. AND the fan is on.

3.12 FAN COIL UNIT

A. Run Conditions - Scheduled:
   1. The unit shall run according to a user definable time schedule in the following modes:
      a. Occupied Mode: The unit shall maintain
         1) 74°F (adjustable) cooling setpoint.
         2) 70°F (adjustable) heating setpoint.
      b. Unoccupied Mode (night setback): The unit shall maintain
         1) 85°F (adjustable) cooling setpoint.
         2) 55°F (adjustable) heating setpoint.

   2. Alarms shall be provided as follows:
      a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adjustable).
      b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adjustable).

   3. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

   4. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

   5. Smoke Detection: The unit shall shut down and generate an alarm upon receiving a smoke detector status.

   6. Fan: The fan shall run anytime the unit is commanded to run, unless shutdown on safeties.

B. Cooling Coil Valve: The controller shall measure the zone temperature and modulate the cooling coil valve to maintain its cooling setpoint.
   1. The cooling shall be enabled whenever:
      a. Outside air temperature is greater than 60°F (adjustable).
      b. AND the zone temperature is above cooling setpoint.
      c. AND the fan is on.

   2. The cooling coil valve shall open whenever the freezeastat (if present) is on.

C. Heating Coil Valve: The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
   1. The heating shall be enabled whenever:
      a. Outside air temperature is less than 65°F (adjustable).
      b. AND the zone temperature is below heating setpoint.
      c. AND the fan is on.

   2. The heating coil valve shall open whenever the freezeastat (if present) is on.

D. Economizer: The controller shall measure the zone temperature and modulate the mixed air dampers in sequence to maintain the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adjustable) open whenever occupied.
   1. The economizer shall be enabled whenever:
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

a. Outside air temperature is at least 3°F (adjustable) less than the Zone Temperature.
b. AND the outside air temperature is less than 75°F (adjustable)

2. The economizer shall close whenever the freezestat (if present) is on.

E. The outside air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

F. Minimum Outside Air Ventilation - Fixed Percentage: The outside air dampers shall maintain a minimum position (adjustable) during building occupied hours and be closed during unoccupied hours.

   1. Fan Status: The controller shall monitor the fan status.
   2. Alarms shall be provided as follows:
      a. Fan Failure: Commanded on, but the status is off.
      b. Fan in Hand: Commanded off, but the status is on.
      c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adjustable).

G. Environmental Index: When the zone is occupied, the controller will monitor the deviation of the zone temperature from the heating or cooling setpoint and calculate a 0 - 100% Environmental Index which gives an indication of how well the zone is maintaining comfort. The controller will also calculate the percentage of time since occupancy began that the Environmental Index is 70% or higher. Optionally, a weighting factor can be configured to adjust the contribution of the zone to the rollup average index based upon the floor area of the zone, importance of the zone, or other static criteria.

3.13 AIR SOURCE HEAT PUMP

A. Run Conditions - Scheduled: The unit shall run according to a user definable time schedule in the following modes:

   1. Occupied Mode: The unit shall maintain
      a. A 74°F (adjustable) cooling setpoint
      b. A 70°F (adjustable) heating setpoint
   2. Unoccupied Mode (night setback): The unit shall maintain
      a. A 85°F (adjustable) cooling setpoint.
      b. A 55°F (adjustable) heating setpoint.

   3. Alarms shall be provided as follows:
      a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adjustable).
      b. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adjustable).
      c. Zone Setpoint Adjust: The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
      d. Zone Unoccupied Override: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
      e. Freeze Protection: The unit shall shut down and generate an alarm upon receiving a freezestat status.
      f. Smoke Detection: The unit shall shut down and generate an alarm upon receiving a smoke detector status.

   4. Fan: The fan shall run anytime the unit is commanded to run, unless shutdown on safety.

B. Heating and Cooling - 1 Compressor Stage: The controller shall measure the zone temperature and cycle the compressor to maintain its setpoint. To prevent short cycling, the stage shall have...
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. The heating shall be enabled whenever:
   a. Outside air temperature is less than 65°F (adjustable).
   b. AND the fan is on.
   c. AND the reversing valve is in heat mode.

2. The cooling shall be enabled whenever:
   a. Outside air temperature is greater than 60°F (adjustable).
   b. AND the fan is on.
   c. AND the reversing valve is in cool mode.

3. On mode change, the compressor shall be disabled and remain off until after the reversing valve has changed position.

4. Alarms shall be provided as follows: Compressor Runtime Exceeded: The compressor runtime exceeds a user definable limit (adjustable).

C. Economizer: The controller shall measure the zone temperature and modulate the mixed air dampers in sequence to maintain the zone cooling setpoint. The outside air damper shall maintain a minimum adjustable position of 20% (adjustable) open whenever occupied.

1. The economizer shall be enabled whenever:
   a. Outside air temperature is at least 3°F (adjustable) less than the zone temperature.
   b. AND the outside air temperature is less than 75°F (adjustable)

2. The economizer shall close whenever the freeze stat (if present) is on.

D. The outside air damper shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

E. Minimum Outside Air Ventilation - Fixed Percentage: The outside air dampers shall maintain a minimum position (adjustable) during building occupied hours and be closed during unoccupied hours.

F. Supplemental Electric Heating Stage: The controller shall measure the zone temperature and stage the heating to maintain its heating setpoint should the compressors not meet the heating demand. To prevent short cycling, the stage shall have a user definable (adjustable) minimum runtime.

1. The heating shall be enabled whenever:
   a. The heat pump is in heating mode.
   b. AND the zone temperature is below heating setpoint.
   c. AND the fan is on.

2. Fan Status: The controller shall monitor the fan status.

3. Alarms shall be provided as follows:
   a. Fan Failure: Commanded on, but the status is off.
   b. Fan in Hand: Commanded off, but the status is on.
   c. Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adjustable).

G. Environmental Index: Environmental Index: When the zone is occupied, the controller will monitor the deviation of the zone temperature from the heating or cooling setpoint and calculate a 0 - 100% Environmental Index which gives an indication of how well the zone is maintaining comfort. The controller will also calculate the percentage of time since occupancy began that the Environmental Index is 70% or higher. Optionally, a weighting factor can be configured to adjust the contribution of the zone to the rollup average index based upon the floor area of the zone, importance of the zone, or other static criteria.

3.14 KITCHEN MAKEUP AIR UNIT - SUPPLY AIR TEMP & VARIABLE VOLUME

A. Run Conditions - Interlocked: The unit MAU --- shall be interlocked to run whenever the associated kitchen exhaust fans are in operation --- runs unless shutdown on safeties.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

B. Freeze Protection: The unit shall shut down and generate an alarm upon receiving a freezestat status.

C. Outside Air Damper: The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open. The outside air damper shall close 4 sec (adjustable) after the supply fan stops.
   1. Alarms shall be provided as follows:
      a. Outside Air Damper Failure: Commanded open, but the status is closed.
      b. Outside Air Damper in Hand: Commanded closed, but the status is open.

D. Supply Fan: The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adjustable) minimum runtime, unless shutdown on safeties.
   1. Alarms shall be provided as follows:
      a. Supply Fan Failure: Commanded on, but the status is off.
      b. Supply Fan in Hand: Commanded off, but the status is on.
      c. Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adjustable).
      d. Supply Fan VFD Fault

E. Variable Volume Supply Airflow: The BMS shall monitor auxiliary contacts on local kitchen exhaust hoods indicating motorized damper position. The VFD shall modulate the airflow per a step function based on how many hoods are in use. Controls contractor shall write this sequence, with airflows included and provide during controls submittal phase.

F. Supply Air Temperature Setpoint - Fixed: The controller shall monitor the supply air temperature and shall maintain a fixed supply air temperature setpoint of 65°F in cooling mode and 70°F in heating model.

G. Cooling Coil Valve: The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint.
   1. The cooling shall be enabled whenever:
      a. Outside air temperature is greater than 60°F (adjustable).
      b. AND the supply air temperature is above cooling setpoint.
      c. AND the fan status is on.
   2. The cooling coil valve shall open to 50% (adjustable) whenever the freezestat is on.

H. Heating Coil Valve: The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
   1. The heating shall be enabled whenever:
      a. Outside air temperature is less than 65°F (adjustable).
      b. AND the supply air temperature is below heating setpoint.
      c. AND the fan status is on.
   2. The heating coil valve shall open to 100% (adjustable) whenever the freezestat is on.

I. Prefilter Differential Pressure Monitor: The controller shall monitor the differential pressure across the prefilter.
   1. Alarms shall be provided as follows: Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adjustable).

J. Supply temperature monitoring
   1. Alarms shall be provided as follows:
      a. High Supply Air Temp: If the supply air temperature is greater than 120°F (adjustable).
      b. Low Supply Air Temp: If the supply air temperature is less than 45°F (adjustable).
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

3.15 KITCHEN EXHAUST FAN – VARIABLE VOLUME

A. Run Conditions - Interlocked: The fan(s) shall be interlocked to run whenever any associated kitchen exhaust hood is in operation unless shutdown on safeties.

B. Fan Status: The controller shall monitor the fan status.
   1. Alarms shall be provided as follows:
      a. Fan Failure: Commanded on, but the status is off.
      b. Fan in Hand: Commanded off, but the status is on.
      c. Exhaust Fan VFD Fault

C. Variable Volume Supply Airflow: The BMS shall monitor auxiliary contacts on local kitchen exhaust hoods indicating motorized damper position. The VFD shall modulate the airflow per a step function based on how many hoods are in use. Controls contractor shall write this sequence, with airflows included and provide during controls submittal phase.

3.16 CHILLED WATER LOOP PUMPS

A. Chilled Water Pump System - Run Conditions: The chilled water pumps shall be enabled whenever:
   1. A definable number of chilled water coils need cooling.
   2. AND the outside air temperature is greater than 54°F (adjustable).
   3. To prevent short cycling, the chilled water pump system shall run for and be off for minimum adjustable times (both user definable).
   4. The pumps shall run for freeze protection anytime the outside air temperature is less than 38°F (adjustable).

B. Chilled Water Pump Lead/Lag Operation - Three Equal Sized Pumps Running in Parallel:
   1. The three variable speed chilled water pumps shall operate in a lead/lag fashion.
      a. The lead pump shall run first.
      b. If any pump fails, the next available pump shall stage on and the failed pump shall be removed from operation.
      c. Additional pumps shall stage on as required to maintain chilled water differential pressure.
   2. The designated staging order (user definable) of the pumps shall rotate on one of the following conditions (user selectable):
      a. manually through a software switch
      b. if pump runtime (adjustable) is exceeded
      c. daily
      d. weekly
      e. monthly
   3. Alarms shall be provided as follows:
      a. Chilled Water Pump 1
         1) Failure: Commanded on, but the status is off.
         2) Running in Hand: Commanded off, but the status is on.
         3) Runtime Exceeded: Status runtime exceeds a user definable limit.
         4) VFD Fault.
      b. Chilled Water Pump 2
         1) Failure: Commanded on, but the status is off.
         2) Running in Hand: Commanded off, but the status is on.
         3) Runtime Exceeded: Status runtime exceeds a user definable limit.
         4) VFD Fault.
      c. Chilled Water Pump 3
         1) Failure: Commanded on, but the status is off.
         2) Running in Hand: Commanded off, but the status is on.
         3) Runtime Exceeded: Status runtime exceeds a user definable limit.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

4) VFD Fault.

C. Chilled Water Differential Pressure Control:
   1. The controller shall measure the chilled water differential pressure and modulate the three chilled water pump VFDs in sequence to maintain its chilled water differential pressure setpoint. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
      a. The controller shall modulate the chilled water pump speeds to maintain a chilled water differential pressure of 12 lbf/in² (adjustable). The VFDs minimum speed shall not drop below 20% (adjustable).
      b. The lead pump shall run anytime the manager is enabled. On dropping chilled water differential pressure, additional pumps shall stage on and modulate to maintain setpoint as follows:
         1) The controller shall modulate the lead pump to maintain setpoint.
         2) If the lead pump cannot maintain setpoint and its speed rises above 90% (adjustable), the second pump shall stage on and modulate in unison with the lead pump.
      c. If both pumps cannot maintain setpoint and their speed rises above 90% (adjustable), the third pump shall stage on and modulate in unison with the other two pumps.
   2. On rising chilled water differential pressure, the pumps shall stage off as follows:
      a. If the setpoint is maintained and the speed of the three pumps drops by a user definable amount, the third pump shall stage off.
      b. If the setpoint is maintained and the speed of the remaining two pumps drops by a user definable amount, the second enabled pump shall stage off.
      c. The controller shall continue to modulate the lead pump to maintain setpoint.
      d. To prevent short cycling, there shall be a user definable (adjustable) delay between stages, and each stage shall have a user definable (adjustable) minimum runtime.
   3. Alarms shall be provided as follows:
      a. High Chilled Water Differential Pressure: If the chilled water differential pressure is 25% (adjustable) greater than setpoint.
      b. Low Chilled Water Differential Pressure: If the chilled water differential pressure is 25% (adjustable) less than setpoint.

D. Chilled Water Temperature Monitoring: The following temperatures shall be monitored:
   1. Chilled water supply.
   2. Chilled water return.
   3. Alarms shall be provided as follows:
      a. High Chilled Water Supply Temp: If the chilled water supply temperature is greater than 55°F (adjustable).
      b. Low Chilled Water Supply Temp: If the chilled water supply temperature is less than 38°F (adjustable).

3.17 HOT WATER LOOP PUMPS

A. Hot Water Pump Run Conditions:
   1. The hot water pumps shall be enabled whenever:
      a. A definable number of hot water coils need heating.
      b. AND outside air temperature is less than 54°F (adjustable).
   2. The pumps shall run for freeze protection anytime outside air temperature is less than 36°F (adjustable).
   3. To prevent short cycling, the pump shall run for a minimum time and be off for a minimum time (both user adjustable).

B. Hot Water Pump Lead/Lag Operation - Three Equal Sized Pumps Running in Parallel:
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. The three variable speed hot water pumps shall operate in a lead/lag fashion.
   a. The lead pump shall run first.
   b. If any pump fails, the next available pump shall stage on and the failed pump shall be removed from operation.
   c. Additional pumps shall stage on as required to maintain hot water differential pressure.

2. The designated staging order (user definable) of the pumps shall rotate on one of the following conditions (user selectable):
   a. manually through a software switch
   b. if pump runtime (adjustable) is exceeded
   c. daily
   d. weekly
   e. monthly

3. Alarms shall be provided as follows:
   a. Hot Water Pump 1
      1) Failure: Commanded on, but the status is off.
      2) Running in Hand: Commanded off, but the status is on.
      3) Runtime Exceeded: Status runtime exceeds a user definable limit.
      4) VFD Fault.
   b. Hot Water Pump 2
      1) Failure: Commanded on, but the status is off.
      2) Running in Hand: Commanded off, but the status is on.
      3) Runtime Exceeded: Status runtime exceeds a user definable limit.
      4) VFD Fault.
   c. Hot Water Pump 3
      1) Failure: Commanded on, but the status is off.
      2) Running in Hand: Commanded off, but the status is on.
      3) Runtime Exceeded: Status runtime exceeds a user definable limit.
      4) VFD Fault.

4. Hot Water Differential Pressure Control:
   a. The controller shall measure the hot water differential pressure and modulate the three hot water pump VFDs in sequence to maintain its hot water differential pressure setpoint. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
   b. The controller shall modulate the hot water pump speeds to maintain a hot water differential pressure of 12 lbf/in2 (adjustable). The VFDs minimum speed shall not drop below 20% (adjustable).

5. The lead pump shall run anytime the manager is enabled. On dropping hot water differential pressure, additional pumps shall stage on and modulate to maintain setpoint as follows:
   a. The controller shall modulate the lead pump to maintain setpoint.
   b. If the lead pump cannot maintain setpoint and its speed rises above 90% (adjustable), the second pump shall stage on and modulate in unison with the lead pump.
   c. If both pumps cannot maintain setpoint and their speed rises above 90% (adjustable), the third pump shall stage on and modulate in unison with the other two pumps.

6. On rising hot water differential pressure, the pumps shall stage off as follows:
   a. If the setpoint is maintained and the speed of the three pumps drops by a user definable amount, the third pump shall stage off.
   b. If the setpoint is maintained and the speed of the remaining two pumps drops by a user definable amount, the second enabled pump shall stage off.
   c. The controller shall continue to modulate the lead pump to maintain setpoint.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

7. To prevent short cycling, there shall be a user definable (adjustable) delay between stages, and each stage shall have a user definable (adjustable) minimum runtime.

8. Alarms shall be provided as follows:
   a. High Hot Water Differential Pressure: If the hot water differential pressure is 25% (adjustable) greater than setpoint.
   b. Low Hot Water Differential Pressure: If the hot water differential pressure is 25% (adjustable) less than setpoint.

C. Hot Water Temperature Monitoring:
   1. The following temperatures shall be monitored:
      a. Hot water supply.
      b. Hot water return.
   2. Alarms shall be provided as follows:
      a. High Hot Water Supply Temp: If the hot water supply temperature is greater than 200°F (adjustable).
      b. Low Hot Water Supply Temp: If the hot water supply temperature is less than 100°F (adjustable).

3.18 STEAM TO HEATING WATER HEAT EXCHANGER  Heat Exchanger System Run Conditions:

1. The heat exchanger system shall be enabled to run whenever:
   a. A definable number of hot water coils need heating.
   b. AND outside air temperature is less than 70°F (adjustable).

2. To prevent short cycling, the heat exchanger shall run for and be off for minimum adjustable times (both user definable).

3. The heat exchanger system shall also run for freeze protection whenever outside air temperature is less than 38°F (adjustable).

B. Hot Water Pump Lead/Lag Operation:
   a. The two hot water pumps shall operate in a lead/lag fashion.
   b. The lead pump shall run first.
   c. On failure of the lead pump, the lag pump shall run and the lead pump shall turn off.
   d. On decreasing hot water differential pressure, the lag pump shall stage on and run in unison with the lead pump to maintain hot water differential pressure setpoint.

2. The designated lead pump shall rotate upon one of the following conditions (user selectable):
   a. manually through a software switch
   b. if pump runtime (adjustable) is exceeded
   c. daily
   d. weekly
   e. monthly

C. Alarms shall be provided as follows:
   1. Hot Water Pump 1
      a. Failure: Commanded on, but the status is off.
      b. Running in Hand: Commanded off, but the status is on.
      c. Runtime Exceeded: Status runtime exceeds a user definable limit.
      d. VFD Fault.
   2. Hot Water Pump 2
      a. Failure: Commanded on, but the status is off.
      b. Running in Hand: Commanded off, but the status is on.
      c. Runtime Exceeded: Status runtime exceeds a user definable limit.
      d. VFD Fault.

D. Hot Water Differential Pressure Control:
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

1. The controller shall measure hot water differential pressure and modulate the hot water pump VFDs in sequence to maintain its hot water differential pressure setpoint.
2. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
3. The controller shall modulate hot water pump speeds to maintain a hot water differential pressure of 12 lbf/in² (adjustable). The VFDs minimum speed shall not drop below 25% (adjustable).
4. On dropping hot water differential pressure, the VFDs shall stage on and run to maintain setpoint as follows:
   a. The controller shall modulate the lead VFD to maintain setpoint.
   b. If the lead VFD speed is greater than a setpoint of 90% (adjustable), the lag VFD shall stage on.
   c. The lag VFD shall ramp up to match the lead VFD speed and then run in unison with the lead VFD to maintain setpoint.
5. On rising hot water differential pressure, the VFDs shall stage off as follows:
   a. If the VFDs speed drops back to 60% (adjustable) below setpoint, the lag VFD shall stage off.
   b. The lead VFD shall continue to run to maintain setpoint.
6. Alarms shall be provided as follows:
   a. High Hot Water Differential Pressure: If 25% (adjustable) greater than setpoint.
   b. Low Hot Water Differential Pressure: If 25% (adjustable) less than setpoint.

E. Hot Water Supply Temperature Setpoint Reset:
1. The hot water supply temperature setpoint shall reset using a trim and respond algorithm based on heating requirements.
2. As the facility’s hot water valves open beyond a user definable threshold (90% open, typ.), the setpoint shall reset to a higher value (adjustable). Once the hot water coils are satisfied (valves closing) then the setpoint shall gradually lower over time to reduce heating energy user.
3. Alarms shall be provided as follows:
   a. High Hot Water Supply Temp: If greater than 200°F (adjustable).
   b. Low Hot Water Supply Temp: If less than 100°F (adjustable).

F. Heat Exchanger Steam Valve - Hot Water Control:
1. The controller shall measure the hot water supply temperature and modulate the steam valve to maintain its setpoint.
2. The steam valve shall be enabled whenever:
   a. The heat exchanger is called to run.
   b. AND hot water supply temperature is below setpoint.
3. The steam valve shall open to 100% (adjustable) whenever the heat exchanger is in freeze protection due to low outside air temperature.
4. The steam valve shall close whenever the hot water supply temperature rises from 180°F to 200°F (adjustable).

3.19 VARIABLE FREQUENCY DRIVE INTERFACE
Variable Frequency Drive (VFD) Interface Monitor: Current VFD status and operating conditions shall be monitored through its communications interface port. The interface shall monitor and trend the points as shown on the Points List.

3.20 STEAM BTU METER
BTU Meter: The controller shall monitor the BTU meter for heating energy consumption on a continual basis. These values shall be made available to the system at all times.
1. Alarm shall be generated as follows:
   a. Meter Failure: Sensor reading indicates a loss of pulse output from the BTU meter.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

B. Peak Demand History: The controller shall monitor and record the peak (high and low) demand readings from the BTU meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

C. Usage History: The controller shall monitor and record BTU meter readings so as to provide an energy consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

3.21 CHILLED WATER ENERGY

Chilled Water Cooling Demand - Energy Meter: The controller shall monitor the chilled water supply temperature, chilled water return temperature and chilled water flow to the building and calculate current energy demand on a continual basis. These values shall be made available to the system at all times.

1. Alarm shall be generated as follows: Invalid Reading: Sensor readings indicate an invalid demand value.

B. Peak Demand History: The controller shall monitor and record the peak (high and low) demand readings from the chilled water energy meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

C. Usage History: The controller shall monitor and record chilled water energy meter readings so as to provide an energy consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

3.22 ELECTRIC METER

Electric Meter: The controller shall monitor the electric meter for electric consumption on a continual basis. These values shall be made available to the system at all times.

1. Alarm shall be generated as follows: Meter Failure: Sensor reading indicates a loss of pulse output from the electric meter.

B. Peak Demand History: The controller shall monitor and record the peak (high and low) demand readings from the electric meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

C. Usage History: The controller shall monitor and record electric meter readings so as to provide a power consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

D. Demand Levels: The controller shall set the system demand level (adjustable) based on the current power consumption readings from the electric meter. There shall be six daily time periods in which the demand shall be adjusted on three levels. These demand levels shall be available for facility equipment to utilize for demand limiting.

1. Demand Level 1: Power consumption has exceeded the first demand level threshold (adjustable).

2. Demand Level 2: Power consumption has exceeded the second demand level threshold (adjustable).

3. Demand Level 3: Power consumption has exceeded the third demand level threshold (adjustable).

3.23 GAS METER

Gas Meter: The controller shall monitor the gas meter for gas consumption on a continual basis. These values shall be made available to the system at all times.

1. Alarm shall be generated as follows: Meter Failure: Sensor reading indicates a loss of pulse output from the gas meter.

B. Peak Demand History: The controller shall monitor and record the peak (high and low) demand readings from the gas meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

C. Usage History: The controller shall monitor and record gas meter readings so as to provide a gas consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

3.24 OUTSIDE AIR CONDITIONS

Outside Air Conditions: The controller shall monitor the outside air temperature and humidity and calculate the outside air enthalpy on a continual basis. These values shall be made available to the system at all times.

1. Alarm shall be generated as follows:

B. Sensor Failure: Sensor reading indicates shorted or disconnected sensor. In the event of a sensor failure, an alternate outside air conditions sensor shall be made available to the system without interruption in sensor readings.
   1. If an OA Temp Sensor cannot be read, a default value of 65°F will be used.
   2. If an OA Humidity Sensor cannot be read, a default value of 50% will be used.

C. Outside Air Temperature History: The controller shall monitor and record the high and low temperature readings for the outside air. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

3.25 WATER FLOW METER

Water Meter: The controller shall monitor the water meter for water consumption on a continual basis. These values shall be made available to the system at all times.

1. Alarm shall be generated as follows: Meter Failure: Sensor reading indicates a loss of pulse output from the water meter.

B. Peak Demand History: The controller shall monitor and record the peak (high and low) demand readings from the water meter. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

C. Usage History: The controller shall monitor and record water meter readings so as to provide a water consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

3.26 INDOOR LIGHTING

A. Run Conditions - Scheduled: The lighting shall be turned on or off based on a user definable schedule.

B. Occupant Override: A timed local override control will allow an occupant to override the schedule and turn the lighting on for an adjustable period of time. At the expiration of this time, control of the lighting will automatically return to the schedule.

C. Warning Flash: The output will cycle off (flash) 5 times (adj) to warn occupants when the lights are about to turn off. This flashing will occur 5 minutes (adj) before the lights turn off.
   1. Alarm shall be provided as follows: Output Runtime Exceeded: Lighting runtime exceeds a user definable limit (adjustable).

3.27 OUTDOOR LIGHTING

A. Run Conditions: The lighting output shall turn on and off based upon the local sunrise and sunset times. The transitions shall be configurable as follows:

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the following:

1. Pipe and Fittings
   a. Chilled water piping above grade
   b. Heating water piping above grade
   c. Low pressure steam piping above grade
   d. Medium pressure steam above grade
   e. High pressure steam above grade
   f. Steam condensate above grade
   g. Temperature and Pressure relief
   h. Radiant heating piping
   i. Refrigerant piping
   j. Cold condensate drainage piping (refer to section 222113 Plumbing Piping)

2. Valves
   a. HVAC Service Valves (125 psig max. working pressure)
   b. HVAC Service Valves (250 psig max. working pressure)
   c. Balancing Valves (125 psig working pressure)
   d. Combination HVAC terminal unit valve line sets
   e. Hydronic Service Pressure Reducing Valves
   f. Hydronic Service Pressure Relief Valves
   g. Steam Service Valves (120 psig max. working pressure)
   h. Steam Service Pressure Reducing Valves
   i. Steam Service Safety Valves

3. Thermometers, gauges and accessories

4. Piping specialties
   a. Pipe escutcheons
   b. Strainers
   c. Drip pans
   d. Air vent
   e. Dielectric unions and flanges
   f. Unions
   g. Flanges
   h. Pipe sleeves
   i. Sleeve seals
   j. Valve boxes

5. Pipe coating

6. Steam traps

7. Expansion Compensators

B. In addition, provide the following:

1. Furnish accessories and labor for flushing and cleaning HVAC piping.
2. Install water treatment systems.
1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Division 01: General Requirements
   1. Section 019113: General Commissioning Requirements

B. Division 22: Plumbing
   1. Section 222113: Plumbing piping for cold condensate drainage piping

C. Division 23: Mechanical
   1. Section 230500: Basic HVAC Materials and Methods
   2. Section 230593: Testing, Adjusting and Balancing
   3. Section 230700: HVAC Insulation
   4. Section 232123: Pumps and Hydronic Specialties
   5. Section 232500: HVAC Water Treatment
   6. Section 235200: Heat Generation
   7. Section 238239: Heat Transfer
   8. Section 238316: Radiant Floor Heating Systems

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

B. Codes and Standards:
   1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
   2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
   3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
   4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
   5. All HVAC work shall comply with the Americans with Disabilities Act (ADA).
   6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

C. Product Control
   1. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.
   2. The general arrangement and locations of piping are shown on the Drawings. Changes may be necessary to accommodate work. Should it be necessary to deviate from arrangement or location indicated in order to meet existing conditions or due to interference with work of other trades, such deviations as offsets, rises and drops in piping that may be necessary, whether shown or not, shall be made without extra expense. Accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for assistance and guidance, and exact locations, distances, and elevations will be governed by actual site conditions.
   3. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
   4. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.
   5. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be
HVAC PIPING, VALVES AND SPECIALTIES
furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.

6. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.

7. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.

8. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Engineer and receive clarification before installing the work.

9. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.

10. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.

11. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for all piping, valves and specialties indicating dimensions, valve CV, flow capacity, pressure setting, tolerances etc.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, valve replacement, and spare parts lists. Include this data, product data, and shop drawings in operating and maintenance manuals.

C. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style number.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data. All pipe, pipe fittings and valves shall be manufactured in North America. Alternatives may be acceptable, but must be submitted and approved by the Engineer prior to bidding.

OR

2. Upon request, the engineer shall be furnished certification by the manufacturer, stating samples representing each lot have been tested and inspected as indicated in governing ASTM specifications have been met. Certification shall be accompanied by test reports as prepared in accordance with relevant ASTM sections governing Test Methods and Inspection. Tension Tests reports shall include breaking load, machined diameter of the test bars, and calculated tensile strength. Certification shall include the legal name and address of the manufacturer.
HVAC PIPING, VALVES AND SPECIALTIES

B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.

C. Grooved steel piping is not acceptable outside of mechanical rooms OR in the utility tunnel OR on the utility tunnel side of the building shut off valve.

D. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

E. Hydronic and Steam Piping Pressure Classifications:
   1. Chilled Water, Condenser Water, Heating Water:
      a. "Normal Pressure" shall be working fluid pressure up to 50 psig.
      b. "Medium Pressure" shall be working fluid pressure up to 100 psig.
      c. "High Pressure" shall be working fluid pressure up to 200 psig.
   2. Steam:
      a. "Low Pressure" shall be working steam pressure up to 20 psig.
      b. "Medium Pressure" shall be working steam pressure 20-80 psig.
      c. "High Pressure" shall be working steam pressure greater than 80 psig.

2.2 PIPE AND FITTINGS

A. Chilled Water Piping: (Above grade)
   1. Steel Pipe:
      a. Pipe Material: ASTM A53 Grade B, Schedule 40 black steel up to 10” diameter. Standard weight black steel for 12” and larger.
      b. Fittings:
         1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded for pipe 2-inch and under; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding
         2) Steel high pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.
         3) Steel grooved end system: Painted, grooved end system, for applications to 300 psi.
            a) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Victaulic rigid Style 107 (“Installation Ready” stab-on design) and 07 (standard coupling), or flexible Style 177 (“Installation Ready” stab-on design and 77 (standard coupling), Tyco-Grinnell rigid Fig. 772 or flexible Fig 705 and 707, or Gruvlok FIG 7001 flexible or FIG 7401 rigid.
            b) Rigid Type: Coupling housings shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 107 or 07, Grinnell Fig 772, or Gruvlok FIG 7401.
            c) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Victaulic Style 177, 077, or W77, Grinnell 705 and 707, or Gruvlok FIG 7001.
            d) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be pressure responsive synthetic rubber, Grade “EHP” or Grade “E” EPDM or EHP.
            e) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.
            f) All grooved couplings, fittings, valves and specialties shall be the products of a single manufacturer.
            g) Grooved manufacturer must be ISO 9001 certified.
   2. Copper Tubing:
HVAC PIPING, VALVES AND SPECIALTIES

a. Pipe Material: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure above grade.

b. Fittings:

1) Copper system: ASME B16.23 cast brass or ANSI/ASME B16.22 wrought copper with the following connection methods.
   a) Soldered or brazed: ASTM B32, solder, Grade 95TA.
      i) 2” and smaller: Make connections using 95%-5% tin-antimony solder joints above grade and sil-fos brazing below grade.
      ii) 2-1/2” and larger: Sil-Fos brazing or brazed and flanged. With prior approval a grooved or pressed copper tubing connection system
   iii) Grooved copper tubing connection system: Victaulic CTS, Tyco-Grinnell, or Gruvlok for above grade joints.
      (1) Grooved couplings: Victaulic Style 607 (Quick Vic), Grinnell Fig. 672, Gruvlok FIG 6400.
      (2) Coupling gaskets shall be pressure responsive type, Grade “EHP” EPDM.
      (3) Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.
      (4) Grooved manufacturer must be ISO 9001 certified.
      (5) Flaring of copper tube to IPS dimensions is unacceptable.
   iv) Pressed Fitting: As an alternate to soldered copper, threaded, or flanged steel, Vic Press 304™ pipe, couplings, and fittings may be used on the 2” and smaller chilled water piping system for normal pressure systems. Pipe shall be ASTM A312, Schedule 10S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring or HNBR seals.

b) Joints: 2” and smaller, threaded or Vic Press 304™ (except in the case of piping located in shafts which must be welded); 2-1/2” and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld, grooved.

3. Stainless Steel: ASTM A312, Stainless Steel Type 304/304L, Schedule 10S, for above grade piping systems with operating pressures to a maximum of 300 psi.

B. Heating Water Piping (Above Grade):

1. Steel Pipe: ASTM A53 Grade B, Schedule 40 black steel up to 10” diameter, and Std. Wt. Black steel for 12” diameter and greater.

   a. Fittings:
      1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding
      2) Steel high-pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.
      3) Steel grooved end system (MECHANICAL ROOM ONLY): Painted, grooved end system, for applications to 230 deg. F and 300 psi.

         a) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Victaulic rigid Style 07 or flexible Style 77.
            i) Rigid Type: Coupling housings cast with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 07.
            ii) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings...
HVAC PIPING, VALVES AND SPECIALTIES

shall be placed in close proximity to the vibration source. Victaulic Style 77.

b) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be pressure responsive synthetic rubber, Grade EPDM, for service up to 230 deg F.

c) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.

d) All grooved couplings, fittings, valves and specialties shall be the products of a single manufacturer.

e) Grooved manufacturer must be ISO 9001 certified.

b. Joints: 2” and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2” and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, ANSI B16.11 socket weld.

2. Copper: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure above grade.

a. Fittings:
   1) Copper system: ANSI B16.22, wrought copper with the following connection methods.
      a) Soldered or brazed:
         i) 2” and smaller: Make connections using 95%-5% tin-antimony solder joints above grade and sil-fos brazing below grade.
         ii) 2-1/2” and larger: Sil-Fos brazing or brazed and flanged.
      b) Grooved copper tubing connection system (MECHANICAL ROOM ONLY): Victaulic CTS, may be used for above grade joint. Used on normal pressure only.
         i) Grooved couplings shall be ASTM A395 and A536 ductile iron, and must be of the angle bolt pad type. (Coupling coated with copper colored alkyd enamel.) Tongue and recess type couplings are unacceptable.
         ii) Coupling gaskets shall be pressure responsive FlushSeal® type, Grade EPDM.
         iii) Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.
         iv) Grooved manufacturer must be ISO 9001 certified.
         v) Flaring of copper tube to IPS dimensions is unacceptable.
      c) As an alternate with prior approval to soldered copper, threaded, or flanged steel, Vic Press 304™ pipe, couplings, and fittings may be used on the 2” and smaller heating water piping in mechanical room applications only. Pipe shall be ASTM A312, Schedule 5S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring seals for service up to 230 deg F.
      d) With prior approval a pressed copper tubing connection system is acceptable for mechanical room application only.

C. Steam Piping:

1. Pipe: Acceptable alternatives are:
   a. ASTM A53 Grade B, Schedule 40 black steel for low and medium pressure (Up to 80 psig, steam working pressure); and ASTM A53 Grade B, Schedule 80 black steel for high pressure (greater than 80 psig steam working pressure).

2. Fittings:
   a. Steel low and medium pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged, Grade 2 flange bolts; ANSI B16.9, steel bevel welding
HVAC PIPING, VALVES AND SPECIALTIES

b. Steel high-pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges, Grade 5 flange bolts; ANSI B16.9, steel bevel weld bevel welding.

3. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

D. Steam Condensate Piping (Gravity and Pumped Pressure Condensate):
1. Steel (low, medium, and high pressure application):
   c. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

2. Copper (low pressure application):
   a. Pipe: ASTM B88, Type K
   c. Joints: Lead-free solder joints. Solder shall be lead-free nickel/silver bearing solder meeting ASTM B-32, ASTM B-828. Flux shall be water soluble and shall meet CDA standard test method 1.0 and ASTM B813-91.

E. Radiant heating in-slab tubing (See Section 238316 Radiant Floors)

F. Temperature and Pressure Relief Valve Discharge Piping:
1. Hydronic Water System (150 psig and 212 deg. F. maximum):
   a. Pipe: Type M or L copper ASTM B88
   b. Pipe: Schedule 40 black steel, ASTM A53 Grade B.
   e. Joints: ANSI B16.22, wrought copper, with 95%-5% tin-antimony solder joints.
   f. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

2. Steam Systems (low, medium, and high pressure applications):
   a. Pipe: Schedule 40 black steel, ASTM A-53 Grade B.
   c. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

G. Refrigerant Piping
1. Pipe: Acceptable alternatives are
   a. ASTM B88, Type K or Type L copper tubing
   b. AC/R pipe.
   2. Fittings: No joints below ground. For pipes below grade wrap with Scotch Wrap #51, ¼" thick, with 20% overlap.

2.3 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted.

B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of balancing valve.
HVAC PIPING, VALVES AND SPECIALTIES

or circuit setter. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Acceptable Manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):

1. Gate, Globe, Check, or Butterfly: Crane, Delta Control Products, Hammond, Gruvlok, Milwaukee, Victaulic, Tyco-Grinnell, Nibco.
3. Lubricated Natural Gas Service Plug Valves: Homestead, Resun, or Rockwell.
5. Steam System Pressure Reducing Valves: Sarco, Fischer, Hoffman, or Spence.
6. Hydronic Pressure Relief Valves: Cash-Acme, Cla-Val, Watts, or Wilkins.
7. Steam System Pressure Relief Valves: Sarco, Fischer, Spence, or Lonergan-Kunkle.
8. Hydronic Balancing valves and Circuit Setters: Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, Nibco (globe style), or Victaulic/Tour & Anderson, Gruvlok, Tyco-Grinnell.

E. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators:

1. Provide standard handwheel for gate, globe valves.
2. Provide 90 degree lever operator for ball valves.
3. Provide 90 degree lever operator for lubricated natural gas plug valves. Exterior located natural gas plug valves shall be provided with removable manual wrench handle, one wrench for each 10 valves.
4. Provide 90 degree locking lever operator for butterfly valves up through 6” size. For 8” size and greater, provide gear operator and handwheel.
5. Provide valve stem extension for lever-operated valves on insulated piping, so handle will clear insulation.
6. For valves sizes 2-1/2” and larger, located more than 10 feet from floor in equipment room areas, provide chain operated sheaves. Provide chain and extend down to 5ft above floor and hook clips on chain arranged to clear walking aisles.

G. Valve Features:

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
2. Bypass: On valves 6” and larger comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving. Provide a 3-valve bypass, minimum 1” size, to consist of two threaded shut-off valves and a plugged drain valve.
3. Drain: Comply with MSS SP-45, and provide ¾” threaded pipe end with cap on chain.
5. Grooved: Valves shall be joined using grooved joint couplings of the same manufacturer. Copper tubing valve grooved ends shall be copper tubing sized.

2.4 HVAC SERVICE VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE
HVAC PIPING, VALVES AND SPECIALTIES

A. Gate Valves:
   1. 2” and Smaller:  Class 150, MSS SP-80, ASTM B62 cast bronze body, bronze union bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Threaded steel pipe: Milwaukee #1151. Soldered copper pipe: Milwaukee #1169.
   2. 2-1/2” and Larger:  Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2885-M.

B. Globe Valves:
   1. 2” and Smaller:  Class 150, MSS SP-80, ASTM B62 cast bronze body, bronze union bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Threaded steel pipe: Milwaukee #590T. Soldered copper pipe: Milwaukee #1590T.
   2. 2-1/2” and Larger:  Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2981-M.

C. Butterfly Valves:
   1. 2-1/2” and Larger:
      a. MSS SP-67, lug type, ductile iron body, stainless steel disc, stainless steel stem, EPDM seat, memory stop control, lever handle thru 5” size and worm gear operator for 6” and larger. Mount stem in horizontal position. Milwaukee #ML32E
      b. 2-1/2” through 12” grooved end type, Black enamel coated ASTM A395 and A536 ductile iron body, elastomer encapsulated or nickel-plated ductile iron disc offset to provide continuous 360 degree seating, with integrally cast or Type 416 stainless steel stem, memory stop control, lever handle thru 5” size and worm gear operator for 6” and larger. Mount stem in horizontal position. Victaulic Vic®-300 MasterSeal, Tyco Grinnell Model B302, Gruvlok FIG 7700 Series.
      c. 14” through 24” grooved end type, PPS (Polyphenylene Sulfide) coated ASTM A395 and A536 ductile iron body, PPS coated ASTM A395 and A536 ductile iron disc with mounted elastomer seal, stainless steel stem, with gear operator. Victaulic Vic®-300 AGS (300 psi maximum pressure.), Tyco-Grinnell Model B308, Gruvlok FIG 7700 series.
      d. 2-1/2” through 6” copper tube dimensioned grooved end type, CDA-836 cast bronze body, elastomer encapsulated ductile iron disc with integrally cast stem, memory stop control, lever handle thru 5” size and worm gear operator for 6”. Mount stem in horizontal position. Victaulic Series 608, Tyco-Grinnell Model B680, or Gruvlok BFV.

D. Ball Valves:
   1. 2” and Smaller:
      a. 600 psi, 2-piece brass body, stainless steel ball, Teflon seat, brass stem, steel handle, full port. Threaded steel ends for iron pipe and soldered ends for copper pipe. Threaded steel pipe: Milwaukee #BA-100. Soldered copper pipe: Milwaukee #BA-150.
      b. 300 psi maximum operating pressure, 2-piece brass body, chrome plated brass ball and stem, TFE seats, steel handle, standard port. Vic Press 304™ ends for stainless steel pipe. Victaulic Series 589.

E. Check Valves:
   1. 2” and Smaller:  Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, screwed cap, swing type, Teflon bronze disc. Threaded steel ends for iron pipe and soldered ends for copper pipe. Threaded steel pipe: Milwaukee #1509T. Soldered copper pipe: Milwaukee #1509.
   2. 2-1/2” and Larger:
HVAC PIPING, VALVES AND SPECIALTIES

a. Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings. Milwaukee #F-2974M

b. 300 psi maximum operating pressure, ASTM A395 and A536 ductile iron body and closure, grooved ends, coupled cap, swing type, stainless steel disc with elastomer seat. Victaulic Series 712, Gruvlok FIG 7800.

3. Silent Check 2-1/2" and Larger:
   a. Class 125, ASTM A126 class B cast iron body, flanged globe style, silent non-slam design, spring loaded, center guided, bronze trim, stainless steel spring and screws. Milwaukee #1800
   b. 365 psi maximum operating pressure, ASTM A395 and A536 ductile iron body, grooved ends, stainless steel spring and shaft.
      1) 2-1/2" and 3": Black enamel coated, stainless steel aluminum bronze disc with mounted elastomer seal and machined seat. Victaulic Series 716H, or Gruvlok FIG 7800.
      2) 4" – 12": Black enamel coated body, elastomer encapsulated ductile iron disc with welded-in nickel seat. 300 psi maximum operating pressure, Victaulic Series 716, Tyco-Grinnell Model 590, or Gruvlok FIG 7800.
      3) 14" – 24": Black enamel coated body, stainless steel disc, with EPDM seat bonded to the valve body, 230 psi maximum operating pressure, AGS grooved ends. Victaulic Series W715.

F. Drain Valves:
   1. Threaded or soldered ends, Class 125, ASSE 1005, bronze body, screw-in bonnet, rising stem, composition disc, ¾" hose outlet.
   2. Threaded or soldered ends, Class 600, bronze body, 2-piece ball valve, ¾" hose outlet with cap and chain. Milwaukee #BA-100/150H.

2.5 HVAC SERVICE VALVES: MAXIMUM 250 PSIG SYSTEM WORKING WATER PRESSURE

A. Gate Valves:
   1. 2" and Smaller: Class 200, MSS SP-80, ASTM B61, threaded ends, cast bronze body, cast iron union bonnet, cast iron wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Milwaukee #1153 or equal.
   2. 2-1/2" and Larger: Class 200, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, OS & Y, cast iron bonnet, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2984 or equal.

B. Globe Valves:
   1. 2" and Smaller: Class 200, MSS SP-80, ASTM B62 cast bronze body, bronze union bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Threaded steel pipe: Milwaukee #570.
   2. 2-1/2" and Larger: Class 200, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, bolted bonnet and disc, bronze trim, OS & Y, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2983-M.

C. Ball Valves:
   1. 2" and Smaller:
      a. MSS SP-110, 1000 psig WOG rating up to 300 deg. F., Carbon steel 3-piece body, threaded ends, stainless steel ball, reinforced Teflon with 15% glass fiber seat, stainless steel stem, stainless steel lever handle, conventional port. Milwaukee #30CSOF or equal.
      b. 300 psi maximum operating pressure, 2-piece brass body, chrome plated brass ball and stem, TFE seats, steel handle, standard port. Vic Press 304™ ends for stainless steel pipe. Victaulic Series 589 or equal.

D. Check Valves:
   1. 2" and Smaller: Class 200, MSS SP-80, ASTM B61 and ASTM B16, cast bronze body, threaded ends, screwed cap, swing Y-pattern type, bronze disc. Milwaukee #508
HVAC PIPING, VALVES AND SPECIALTIES

2. 2-1/2" and Larger:
   a. 200 lb. WOG, MSS SP-71, ASTM A126 Class B cast iron body, bolted cap, swing type, bronze disc with bronze face rings. Milwaukee # 2970
   b. 300 psi maximum operating pressure, ASTM A395 and A536 ductile iron body and closure, grooved ends, coupled cap, swing type, stainless steel disc with elastomer seat. Victaulic Series 712.
   c. 365 psi maximum operating pressure, ASTM A395 and A536 ductile iron body, grooved ends, stainless steel spring and shaft.
      1) 2-1/2" and 3": Black enamel coated, stainless steel aluminum bronze disc with mounted elastomer seal and machined seat. Victaulic Series 716H.
      2) 4" – 12": Black enamel coated body, elastomer encapsulated ductile iron disc with welded-in nickel seat, 300 psi maximum operating pressure, Victaulic Series 716, Tyco-Grinnell Model 590.
      3) 14" – 24": Black enamel coated body, stainless steel disc, with EPDM seat bonded to the valve body, 230 psi maximum operating pressure, AGS grooved ends. Victaulic Series W715.

2.6 STEAM SERVICE VALVES: MAXIMUM 120 PSIG STEAM SYSTEM PRESSURE

A. Gate Valves:
   1. 2" and Smaller: Class 200, 200 lb. SWP, MSS SP-80, ASTM B61, threaded ends, cast bronze body, bronze union bonnet, bronze wedge, rising stem, bronze packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Milwaukee #1153
   2. 2 ½" and Larger: Class 200, 250 lb. SWP, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, OS&Y, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2984

B. Globe Valves:
   1. 2" and Smaller: Class 200, 200 lb. SWP, MSS SP-80, ASTM B61, threaded ends, cast bronze body, bronze bonnet, bronze disc, bronze packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Milwaukee #570.
   2. 2 1/2" and Larger: Class 200, 250 lb. SWP, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, OS&Y, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2983

C. Check Valves:
   1. 2" and Smaller: Class 200, 200 lb. SWP, MSS SP-80, ASTM B61 and ASTM B16, cast bronze body, threaded ends, screwed cap, swing type, bronze disc. Milwaukee #508.
   2. 2-1/2" and Larger: 250 lb. SWP, MSS SP-71, ASTM A126 Class B cast iron body, bolted cap, swing type, bronze disc with bronze face rings. Milwaukee #F-2970.

2.7 BALANCING VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Pressure Independent Water Flow in Variable Flow Systems:
   1. 1/2" and Larger: Construction and attachment style as required by piping system.
      Internal working parts and removable flow cartridge shall be stainless steel or DZR Brass. Valves shall be factory set and shall automatically limit the flow to specified capacities with 5% +/- accuracy over the entire operating pressure differential. Quick disconnect valves shall be extended to outside of insulation. Griswold, Victaulic.

B. Pressure Dependent Water Flow in Constant Flow Systems:
   1. 1/2" and Larger: Construction and attachment style as required by piping system.
      Characterized ball valve or Y-type globe valve design with memory stop. Valves shall be field adjustable. Quick disconnect valves shall be extended to outside of insulation. Install in pipe with minimum length of unrestricted straight pipe equivalent to five pipe diameters upstream and two pipe diameters downstream. Preso Venturi B-Plus series, Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only),
HVAC PIPING, VALVES AND SPECIALTIES
Armstrong, Nibco (Globe style), Tyco-Grinnell, or Victaulic/Tour & Anderrson or Gruvlok (Y-globe type only), Series 786 (soldered), Series 787 (threaded), Series 788 (flanged or Series 789 (grooved).

2.8 TERMINAL UNIT ASSEMBLIES – COIL KITS
A. General: As an alternative to built-up valve and connection assemblies for terminal units, a complete kit consisting of valves, strainer, balancing, and flexible hose connection may be provided. Victaulic Koil Kit Series 799 or 79V, or equal by others.

2.9 RE INDEPENDENT TEMPERATURE CONTROL VALVES (COIL CONTROL VALVES)
A. Modulating control valves shall be pressure independent characterized two-way actuated flow control valves. The flow rate through the valve shall not vary more than + or - 5% due to system pressure fluctuations across the valve in the selected operating range.
B. Electronic valves at all variable air volume terminals, constant volume terminals, fan powered terminals, and zone reheat coils with valve connections of 1" (18 gpm) or less in size may utilize floating point control. All air handler coils shall utilize proportional control electronic valves.
C. The rangeability of the valve shall be 90:1 (minimum).
D. The valve bodies shall be of cast brass and rated for 200 PSI working pressure (minimum). All internal parts shall be stainless steel, teflon, brass, or bronze. The valves shall be serviceable without removing them from the piping system. Valve flow characteristics shall be able to be changed without removing the valve from the piping system.
E. Balancing valves shall not be required where these control valves are installed. Flow performance curves shall be provided with each valve
F. The actuator shall modulate the control valve from 0 to 100% design flow. The actuator shall be directly coupled to the valve at the factory.
G. Pressure/temperature ports (Pete's Plugs) shall be installed at the factory in each valve larger than 1" or be integral to the valve. Two ports shall be used to measure inlet and outlet pressure to the valve.
H. Manufacturer: Delta Control Products AutoTouch, Honeywell VRN, Belimo PICCV, Victaulic TCP Series or T/A 793/794 used in conjunction with Victaulic T/A balancing valves, or approved equal by Flow Control Industries, Inc. or Griswold. Valves shall be provided by controls provider and installed by piping.

2.10 HYDRONIC SYSTEM PRESSURE REDUCING VALVES
A. Single seated, direct operated type; high capacity, having bronze body with strainer, by-pass feature, pressure gauge tappings and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and fall-off at inlet and outlet pressure indicated.
1. 25-75 psig range: Watts #U5 series.
2. 10-25 psig range: Watts #N256
3. Provide with asbestos-free insulating cover, with silicone treated fiberglass cover, 1” insulation, and Velcro fasteners. Suitable for temperatures up to 550 deg. F.
4. Spence #Series E or equal.

2.11 HYDRONIC SYSTEM PRESSURE RELIEF VALVES
A. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required. Watts #740 Series.
B. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting (or pressure setting as indicated on construction documents), and so stamped. Size as required. Watts #100XL, 40XL, 140, N240, or 340 Series.

2.12 HYDRONIC SYSTEM REDUCED PRESSURE BACKFLOW PREVENTION VALVES
HVAC PIPING, VALVES AND SPECIALTIES

A. General: All backflow prevention valves shall be State approved. Coordinate with plumbing system for provision of domestic water to reduced pressure backflow prevention to protect domestic water system from connection to hydronic piping systems.

B. Reduced Pressure Backflow Preventer
   1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-QT-S-HW valve with #909AG air gap fitting.
   2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-S-OSY valve with #909AG air gap fitting.

2.13 STEAM PRESSURE REDUCING VALVES

A. The pressure regulator shall be of the pilot-actuated diaphragm operated type. The main valve shall be single seated with hardened stainless steel trim: the regulator body shall be cast iron or steel. The pilot shall be bolted directly to the regulator body. The regulator shall be capable of dead-end shut-off.
   1. Size 1/2"-2", NPT ends, cast iron, 250 psig maximum operating pressure, 450 deg. F. maximum temperature.
   2. Size 2-1/2" and greater, ANSI 250 lb flanged ends, 250 psig maximum operating pressure, 450 deg. F. maximum temperature.
   3. Spring shall be selected to provide outlet pressure as indicated in equipment schedules or on construction documents.

2.14 STEAM SYSTEM SAFETY VALVES

A. Size 1/2"-1-1/4". ASME sections I and VIII for steam service. Safety valve shall be fitted with enclosed spring and external lifting lever. Valve shall be rated up to 250 psi and 450 deg. F. steam. Shall be furnished with manufacturer’s standard connections and valve body of cast brass with bronze Teflon internals.
   1. NPT inlet and outlet
   2. Provide relief setting as per equipment schedules or indicated on construction documents.
   3. Inlet pressure as per equipment schedules or indicated on construction documents.
   4. Flow capacity as per equipment schedules or indicated on construction documents.
   5. Provide with manufacturer drip pan elbow.
   6. Provide manufacture data on capacity steam flow, with 90% rating at 10% over pressure, as part of valve submittal
   7. Spence Series #31, 41 and 41A, or equal.

B. Size 1½" and above. ASME sections I and VIII for steam service. Safety valve shall be fitted with enclosed spring and external lifting lever. Valve shall be rated up to 250 psi and 450 deg. F. steam. Shall be furnished with manufacturer’s standard connections and valve body of cast iron with bronze internals.
   1. ANSI 250 lb. Fanged end inlet and outlet.
   2. Provide relief pressure setting as per equipment schedules or indicated on construction documents.
   3. Inlet pressure as per equipment schedules or indicated on construction documents.
   4. Flow capacity as per equipment schedules or indicated on construction documents.
   5. Provide with manufacturer drip pan elbow.
HVAC PIPING, VALVES AND SPECIALTIES

6. Provide manufacture data on capacity steam flow, with 90% rating at 10% over-pressure, as part of valve submittal.
7. Spence Series #31, 41 and 41A, or equal.

2.15 THERMOMETERS AND GAUGES

A. General:
1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
2. No mercury shall be used in thermometers due to hazardous material classification.

B. Thermometers:
1. Bi-Metal Type: Provide bi-metal glass thermometers of materials, capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.
   a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3" diameter dial, with adjustable angle.
   b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
   c. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
   d. Stem: Stainless steel, adjustable angle socket, length to suit installation.
2. Glass Thermometer: Provide adjustable angle 9" thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
   a. Case: Aluminum or Valox
   c. Scale: Aluminum painted white with black markings.
   d. Connection: 1/2" NPT with thermowell, 1-1/4" UNF swivel nut without thermowell.
3. Photovoltaic Cell Powered LCD Thermometer
   a. Case: ABS Plastic
   b. Accuracy: 1% of full scale
   c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celcius.
   d. Connection: 3/4" NPT with thermowell 1-1/4" UNF swivel nut without thermowell.
4. Range: Conform to the following:
   a. Hot Water: 20°F - 240°F with 2°F scale divisions.

C. Thermometer Test Wells:
1. Provide thermometer test wells as indicated, constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

D. Temperature/Pressure Gauge Connector Test Plugs (Pete’s Plugs):
1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200° F (93° C). Construct of brass or stainless steel, equip with 1/2” NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8” O.D. probe assembly from dial type insertion thermometer or pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

E. Pressure Gauges:
1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
3. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
4. Connector: Brass with 1/4” male NPT.
HVAC PIPING, VALVES AND SPECIALTIES

5. Scale: White coated aluminum, with permanently etched markings.
6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum 1 psig divisions.

F. Pressure Gauge Cocks:
1. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Gauge cock shall be 1/4-1/2” threaded end, 2-piece bronze body ball valve. Milwaukee #BA-100.
2. Siphon: 1/4” straight coil constructed of brass tubing with 1/4” male NPT on each end.
3. Snubber: 1/4” brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

2.16 PIPING SPECIALTIES

A. General:
1. Provide factory fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements.
2. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Pipe Escutcheons:
1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

C. Low Pressure Y-Type Pipeline Strainers:
1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64” perforations at 233 0.045” perforations per square inch.
2. Threaded Ends, 2” and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with hose bibb. Sarco, Keckley, Wheatley or Mueller.
3. Flanged Ends, 2-1/2” and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with 3/4” drain valve. Sarco, Keckley, Wheatley or Mueller.
4. Grooved Ends, 2-1/2” and Larger: Ductile iron body, bolted screen strainer with off center blowdown fitted with 3/4” drain valve. Victaulic style 730/731/732, Tyco-Grinnell Fig. S853 and S55, Gruvlok FIG 7260/758G, or approved equal.
5. Strainers for steam service shall be installed in horizontal position, so as not to trap condensate.

D. Drip Pans:
1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2”. Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1” copper drain line connection.

E. Steam Safety Valve Drip-Pan Elbows:
1. Provide pre-manufactured drip pan elbows specially designed for steam pressure safety valve discharge, sized to match corresponding steam safety valve discharge size.
2. Sarco, Armstrong, Hoffman, Spence, Kunckle, or approved equal.
F. **Air Vent with Valves:**
   1. Install in all closed and open loop water systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each automatic vent valve to facilitate servicing. A minimum 3/8 inch type "L" copper tubing drain line shall be run to floor sink, floor drain or other approved drain receptacle to carry away water that valve discharges. Manual type vent may be used in lieu of automatic type, where specifically shown on the Drawings. Provide Hoffman #79 or equal by Amtrol, Watts, or Dole.

G. **Dielectric Waterways:**
   1. To effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
   2. Steel to copper, with thermoplastic dielectric lining.
   3. 250 psig rated pressure at 210 deg. F.
   4. Connection: screwed, grooved, sweat, or flanged to match pipe.
   5. Victaulic style 47, Gruvlok FIG 7088/7089 or approved equal.

H. **Dielectric Flanges:** Provide dielectric flanges and dielectric bolt sleeves for flanged transitions between dissimilar metal piping. Watts Series 3100 or approved equal.

I. **Unions:**
   1. Unions shall be of type specified in following schedule:
      a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
      b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
      c. Stainless Steel, 2" and smaller: 300 psi maximum operating pressure, threaded union, with Vic Press 304™ ends.
      d. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
      e. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
      f. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.
      g. Where grooved joint piping systems are utilized, unions are not required. Grooved joint couplings shall serve as unions.
      h. Manufacturer: EPCO, Mueller, Stanley G. Flagg, Victaulic, Tyco-Grinnell, or Watts.

J. **Flanges:**
   1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
   2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.
   3. Type of pipe and corresponding flanges as follows:
      a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
      b. Stainless Steel Pipe, Class 150 stainless steel flange adapter with carbon steel back-up flange and Vic Press 304™ end.
      c. Welded Steel Pipe, 150 lb. black forged steel welding flanges, 1/16" raised face ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.
      d. Grooved Steel Pipe, Class 150, ASTM A395 and A536 ductile iron flange adapter, with pressure responsive synthetic rubber gasket. Victaulic Style 741, Tyco-Grinnell Fig. 71, or Gruvlok FIG 7401.

K. **Flange Gaskets:**
   1. Type: full faced or flat ring to suit flange facings.
HVAC PIPING, VALVES AND SPECIALTIES

2. Shall conform to ASTM F-104
3. Minimum thickness: 1/16”
4. Flange gaskets for medium and high pressure steam service shall be provided with metallic rim.
5. Manufacturer: Garlock style 3200, or approved equal.

L. Pipe Sleeves:
1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
2. Sleeves shall provide a minimum ½ inch annular clearance around pipe.
3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3” and smaller, 20 gauge; 4” to 6”, 16 gauge; over 6”, 14 gauge.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves by Adjust-to-Crete, AMI or Shamrock. Floor sleeves to extend a minimum of 1” above finished floor.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.
9. Cast-in-place watertight device for protecting penetrating objects from expansion and contraction of concrete. Factory-assembled for use in cast-in-place concrete floors and walls and consisting of two outer sleeves and a one-piece radial extended-flange waterstop gasket, with mid-body seal for embedment and sealing to concrete slab and continuous water seal extending to the penetrating pipe.
   a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE; Hydro Preseal, or a comparable product by one of the following:
      1) <Insert manufacturer's name.>
   b. Outer Sleeves: [EPDM] [NBR] <Insert other> attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.
   c. Water Stop Mid-body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve. <Describe size and type of pipe to be inserted in sleeve seal>.

M. Sleeve Seals:
1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.
3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.

N. Watertight Sleeve-Seal Systems
1. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.
HVAC PIPING, VALVES AND SPECIALTIES

a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE; Hydroflame Sleeve, or a comparable product by one of the following:
   1) <Insert manufacturer's name.>

b. Consists of an outer sleeve lined with an intumescent strip, and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.

c. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.

d. Retain subparagraph below if fire resistance rating is required.

e. Provide a [one-hour] [two-hour] [three-hour] fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.

2. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, hot gasses and fire.

a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE; Hydroflame CMD Metal Deck Device, or a comparable product by one of the following:
   1) <Insert manufacturer's name.>

b. Consists of an outer sleeve lined with an intumescent strip, and wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.

c. Includes a cone attached to the base for extending the device through the metal deck and a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.

d. Retain subparagraph below if fire resistance rating is required.

e. Provide a [one-hour] [two-hour] [three-hour] fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.

2.17 VALVE BOXES:

A. Concrete body, cast iron cover with vandal resistant screws, extensions as required to extend full depth to valve. Valve box cover lettering shall correspond to the valve service, "Water", "Gas", "Fire", "Sewer", etc. Christy #G8 or equal.

2.18 STEAM TRAPS

A. Provide steam traps of size, flow capacity, and type as indicated on plans. Manufacturer: Armstrong, Spirax Sarco, Hoffman, or approved equal.

B. Where size or type is not indicated, provide trap of size and type as recommended by trap manufacturer to meet the scheduled equipment capacity or anticipated flow for the application.
   1. Traps shall be sized with minimum 2:1 factor of safety for drip traps on mains.
   2. Traps shall be sized with minimum 3:1 factor of safety for end of main traps, heat exchanger and coil traps, or ahead of pressure reducing valves.

C. Drip traps on steam headers or mains are to be inverted bucket (IB) type or Thermodynamic type.

D. Traps on shell and tube type heat exchangers are to be inverted bucket large vent (IBLV) type or float & thermostatic (F&T) type.

E. Traps on air unit heating coils are to be IBLV or F&T.

F. Traps on radiation or pipe coils are to be IBLV, F&T, or thermostatic.

G. Provide gate valves upstream and downstream of trap and inlet and outlet unions for servicing.

H. Provide strainer upstream of trap and check valve downstream of trap.

I. Provide bypass piping and normally-closed bypass globe valve one pipe size smaller than trap line size at each steam trap.
HVAC PIPING, VALVES AND SPECIALTIES

2.19 EXPANSION COMPENSATORS AND FLEXIBLE PIPING CONNECTIONS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ANSI B31.1 for pressure piping. Vertical piping for domestic hot water, chilled water, heating water, steam and steam condensate shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.

B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Keflex #311 series or approved equal.

C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Metraflex #Metraloop, Unisource V-SF21 Style, or approved equal.

D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Metraflex #SST or approved equal. Provide steel supports to prevent sagging is required.

E. Three grooved joint flexible type couplings may be used in lieu of flexible connectors on steel pipe for vibration attenuation and stress relief. Grooved joint couplings shall be placed in close proximity to the vibration source. For services up to 250°F. Victaulic Style 177 or 77, Tyco Grinnell Fig. 705 and 707 couplings, or Gruvlok FIG 7401.

F. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Metraflex #BBS, Unisource V-BF11 Style, or approved equal. Provide steel supports to prevent sagging is required.

G. Flexible Rubber Connectors (Pump Connections): Concentric spool type expansion joint, single or double arch. Chlorobutyl tube and cover, meeting ASTM specification D2000 Grade 2AA610AB, L13. The body shall be reinforced with rectangular body rings and a minimum of six bias plies of polyester fabric. A hypolon coating shall be applied completely and uniformly to the cover. All expansion joints shall be rated 190 PSI/26 inch vacuum at 250° F for sizes up to and including 12 inch.

1. For heating hot water service and critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26 inch vacuum at 400° F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Manufacturer shall provide documentation utilizing oven aged and cold flexibility tests to verify elastomer capability. Each batch of compound manufactured shall be tested to verify it conforms to the ASTM specifications listed below. Garlock #204HP. No known equals.

<table>
<thead>
<tr>
<th></th>
<th>CHLOROBUTYL</th>
<th>VITON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity</td>
<td>ASTMD 792</td>
<td>ASTMD 792</td>
</tr>
<tr>
<td>Durometer Shore A</td>
<td>ASTMD 2240</td>
<td>ASTMD 2240</td>
</tr>
<tr>
<td>Tensile</td>
<td>ASTMD 412</td>
<td>ASTMD 412</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTMD 412</td>
<td>ASTMD 412</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>POLYESTER</th>
<th>FIBREGLASS/KEVLAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread Count</td>
<td>ASTMD 3775</td>
<td>ASTM 1910</td>
</tr>
<tr>
<td>Gauge</td>
<td>ASTMD 1777</td>
<td>ASTMD 1777</td>
</tr>
<tr>
<td>Weight</td>
<td>ASTMD 3776</td>
<td>ASTM 1910</td>
</tr>
<tr>
<td>Breaking Strength</td>
<td>ASTMD 1682</td>
<td>ASTM 1682</td>
</tr>
</tbody>
</table>
HVAC PIPING, VALVES AND SPECIALTIES

2. For chilled water, condenser water, and non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26 inch vacuum at 250° F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Garlock #206 EZ-FLO or equal.

3. Three grooved joint flexible type couplings may be used in lieu of flexible connectors on steel pipe for vibration attenuation and stress relief. Grooved joint couplings shall be placed in close proximity to the vibration source. For services up to 250°F. Victaulic Style 177 or 77 Or Gruvlok FIG 7401.

H. Flexible Ball Pipe Joints: Provide flexible ball pipe joints where indicated for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Design joints for 360° rotation, and with minimum of 50° angular flexing movement for sizes ¼” to 4”. Provide two composition gaskets for each joint. Barco or approved equal.

1. Certify carbon steel joints for environmental shock testing in accordance with MIL-S-4456 or MIL-S-901C.

2. Comply with Section II of ASME Boiler and Pressure Vessel Code and ASME B31 Power Piping for materials and design of pressure containing parts and bolting.

3. Test each assembly with steam at working pressure of piping system for zero leaks before shipment.

I. Expansion Joints for Grooved Piping: For piping systems fabricated from grooved pipe and couplings, use one of the following methods for expansion compensation:

1. Combination Couplings and Nipples: Provide expansion joints constructed of grooved short pipe nipples and flexible couplings, designed by manufacturer to suit intended service. Provide removable ties to hold joint compressed or expanded during piping fabrication, depending on application. Total joint end movement is dependent on the number of couplings/nipples in the joint. Select couplings and gasket materials to match balance of piping system. Victaulic Series 155 or Gruvlok FIG 7240.

2. Slip-Type Expansion Joints: Provide slip-type expansion joints constructed of carbon steel pipe and couplings, designed by manufacturer to suit intended service. Joint shall be gasketed expansion joint, with grooved ends. Slide section coated with PTFE modified PPS (Polyphenylene Sulfide) coating. Joint suitable for axial end movement up to 3”. Victaulic Style 150. Select couplings and gasket material to match balance of piping system.

3. Three flexible couplings: Use three flexible couplings (Victaulic 177, 75 or 77, Tyco-Grinnell Fig. 705 and 707, or Gruvlok FIG 7401) for the first three connections in close proximity to a pump or chiller to eliminate flexible rubber connectors.

J. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Metraflex #Style IV or equal.

K. Expansion Loops: Provide field fabricated pipe expansion loops as detailed on the drawings or in place of mechanical expansion joints. Expansion loops in IPS steel and roll grooved copper tubing systems shall be accommodated with loops or bends consisting of (8) Victaulic or Gruvlok couplings, (4) 90 degree elbows, and (3) grooved end pipe spools provided in water systems up to 250 deg F in accordance with recommendations for expansion compensation.

2.20 PIPE COATING

A. All exposed above ground steel and copper pipe and fittings in corrosive air environments shall be covered with one of the following methods:

1. Twice Wrap 20 Mill Scotch Wrap PVC No. 51, 50% overlap.

2. Prefabricated extruded plastic cover with joints sealed with two coats of 20 Mill Scotch Wrap No. 51.
2.21 SUPPORTS AND ANCHORS (SEE SECTION 230500)

PART 3 - EXECUTION

3.1 GENERAL
A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.
B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER’S DIRECTIONS
A. Follow manufacturer’s directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION
A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Engineer.
B. The cooperative work not included in the Mechanical Division related to the general construction work is as follows:
   1. All formed concrete work
   2. Framed openings in masonry and other Architectural and Structural elements
   3. Wood grounds and nailing strips in masonry and concrete
C. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and visqueen cover to protect equipment and piping delivered to and stored at the site.

3.4 WORKING PRESSURES
A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.
B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.

3.5 PIPE SIZES TO EQUIPMENT
A. General: Pipe sizes indicated on drawings shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.
B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.6 PIPING INSTALLATION
A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.
B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines.
HVAC PIPING, VALVES AND SPECIALTIES

Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2 inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1 inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.

D. Cleaning: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

3.7 FLUSHING AND CLEANING PIPING SYSTEMS

A. Steam, Steam Condensate, and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

B. Water Piping (condenser, chilled, heating, heat recovery, process cooling piping): Clean systems with chemicals specified in Section 232500 HVAC Water Treatment. Follow the method provided below or a method recommended by the suppliers of the chemicals specified in Section 232500.

1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and similar deleterious substances without damage to any system component. Provide temporary piping or hoses to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any components which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris-carrying velocity of 2.5 to 6 feet per second, if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and contractor’s booster pumps. Flush until clean as approved by the Owner, Architect or Engineer.

2. Cleaning: Using products specified in Section 232500, circulate systems at normal temperature to remove adhering organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and similar substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Before cleaning isolate equipment which is “clean” and where dead-end debris accumulation must not occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body using the velocity of this throttling action. Flush for not less than one hour.

3.8 WATER TREATMENT EQUIPMENT AND SYSTEMS

A. Install water treatment equipment and provide water treatment for systems as designated in Section 232500 HVAC Water Treatment.
3.9 ANTIFREEZE CHARGED PIPING

A. Where indicated on plans or schedules or other specification sections charge piping with antifreeze solution coordinated to provide freeze protection to 10°F below the ASHRAE 99.6 heating db (Freeze Protection Design Temperature).

<table>
<thead>
<tr>
<th>Freeze Protection Design Temperature</th>
<th>Freeze Protection (% Propylene Glycol)</th>
<th>Burst Protection (% Propylene Glycol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>10</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>0</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>-10</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td>-20</td>
<td>46</td>
<td>30</td>
</tr>
</tbody>
</table>

B. Unless otherwise specified, provide percent of fluid by volume of inhibited propylene glycol.

C. Dow Chemicals Dowfrost, Interstate Intercool, or equal inhibited mixture.

D. Provide charging valves, drains, vents, and other hardware as necessary to charge the solution into the piping system.

E. Provide a calculation sheet indicating system volume in gallons and amount of glycol required.

F. Provide a post charging test of the percent of glycol and submit results for review by engineer and owner.

3.10 WELDING

A. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation shall conform to ANSI 31.1 "Power Piping". Welders shall be tested and certified for all positions.

3.11 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings.

B. Provide joints of type indicated in each piping system.

C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

D. Vic Press 304™ Joints: Pipe shall be certified for use with the Vic Press 304™ system. Pipe shall be square cut, +/- 0.030”, properly deburred and cleaned. Pipe ends shall be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly. Use a Victaulic 'PFT' series tool with the proper sized jaw for pressing.

E. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM. B-32, in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications, and shall meet CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such
HVAC PIPING, VALVES AND SPECIALTIES

excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.

1. Manufacturers:
   a. Solder: JW Harris "Bridgit" or Englehard "Silvabrite 100".
   b. Flux: Laco "Flux-Rite 90", MW Dunton "Nokorode CDA Flux", Hercules "Fluid Action Solder Flux".

F. Braze copper tube and fitting socket or extrude joints (T-drill) with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.

G. Piping shall be capped during construction to prevent entry of foreign material.

H. Grooved Joints:
   1. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall meet AWWA C-606 requirements.
   2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer.
   3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
   4. Grooved coupling manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically inspect the product installation. Contractor shall remove and replace any improperly installed products.

I. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0°F.
   2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1 inch long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or un-fused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
   6. At Installer’s option, install forged branch-connection fittings whenever branch pipe is indicated, or install regular T-fitting.

J. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.


L. Adhesive Bonded Joints:
   1. All joints installed or constructed in the field shall be assembled by employees of the contractor who have been trained and certified to the bonding procedure specification provided by the pipe manufacturer. This specification shall meet or exceed the requirements of ASME B31.3, Section A328.2.1. The pipe manufacturer or their authorized representative shall train the contractor’s employees in the proper joining and assembly procedures required for the project including hand-on participation by the contractor’s employees in accordance with the manufacturer’s specification.
3.12 VALVES

A. General: Except as otherwise indicated, comply with the following requirements.
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping, strainers and other equipment. Locate valves so as to be accessible and so that separate support can be provided as necessary.
2. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case where stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
3. Install butterfly valves with stems mounted horizontally.
4. All valves mounted higher than 10 feet above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 5 feet above floor.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
1. Copper Pipe, 2-1/2" and Smaller: One of the following, at installer's option:
   a. Soldered-joint valves
   b. Grooved-joint valves
2. Copper Pipe, 2-1/2" and Larger: Grooved-joint valves.
4. Steel Pipe, 2" and Smaller: Threaded joint valves.
5. Steel Pipe, sizes 2 ½" and larger: One of the following, at installer's option:
   a. Flanged valves
   b. Lug valves
   c. Grooved-end valves

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, globe, ball, plug, circuit setter, glove, and butterfly valves to comply with ASME B31.9.

G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

H. Wafer Check: Install between 2 flanges in horizontal or vertical position.

I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception

J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

K. Valve Identification: Tag each valve in accordance with "Mechanical Identification" section.

L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

M. Install so handles are readily available. Locate valves and valve handles for appropriate maintenance access.
N. Gasket and O Ring Material: Valve manufacturer is responsible for submittals. Provide gasket and O ring material best suited for the both piping systems.

3.13 TEMPERATURE GAUGES

A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gages to be installed with snubbers to absorb system shock.

B. Install in the following locations, and elsewhere as indicated:
   1. At inlet and outlet of hot water heaters
   2. At inlet and outlet of boilers
   3. At inlet and outlet of chillers and cooling towers
   4. At inlet and outlet of heat exchangers
   5. At inlet and outlet of process equipment. (Unless equipment is provided with digital readout.)

3.14 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [1-inch (25-mm)] <Insert dimension> annular clear space between piping and concrete slabs and walls.

Retain subparagraph below when cast-in-place watertight sleeve seals are required.

1. When cast-in-place watertight sleeve seals are required, select sleeve size to match the size and type of pipe to be installed.

Retain subparagraph below if applicable.

2. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

   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 (50 mm)] <Insert dimension> above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
   4. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping." Exception: When fire-resistance-rated cast-in-place watertight sleeve seals are required for floor penetrations, additional firestopping is not necessary.

3.15 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
HVAC PIPING, VALVES AND SPECIALTIES

C. Aboveground, Cast-in-Place Watertight Sleeves. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
   1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
   2. Position cast-in-place watertight sleeve in wall space securing sleeve to reinforcing steel using tie wire.

D. Underground, Exterior-Wall, Cast-in-Place Watertight Penetrations. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
   1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
   2. Secure sleeve to the reinforcing steel using tie wire.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete, and finish even with top of sleeve.

3.16 EXPANSION LOOPS

A. Expansion Loops: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.

B. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

3.17 EXPANSION COMPENSATORS

A. Install as noted on plans. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer's recommendations.

3.18 EXCAVATION AND BACKFILL

A. Underground piping shall be installed in stable, open trenchwork. Trench excavations shall be a minimum of 16 inch wide, true to line and grade. Contractor shall exercise all due shoring and safety procedures. No stones larger than 1 inch may be present in the trench to a minimum depth of 4 inch below the trench bottom. The trench shall be free of job site debris, and free of corrosive media. Pipe crown shall be not less than 36 inch below the finished ground surface for metallic pipe, and 40 inch for non-metallic pipe, unless otherwise indicated on the drawings or directed by the Architect. Trenches shall be kept free of excess moisture, and shall be kept open for only a short a time as necessary for installation, testing and inspection. Dispose of surplus excavation and seepage water as directed by the Architect.

B. Piping shall be properly bedded and backfilled over stable trench bottom to a level of at least 12 inch above the pipe crown with thin layers of unwashed sand, dampened but not puddled, and free of organic or corrosive materials and excessive moisture. Backfill shall be placed in thin layers not to exceed 6 inch and tamped by mechanical tampers to a minimum 90% Standard Proctor Density, in accordance with ASTM D-1557-58T. Trenches shall be backfilled to a minimum depth of 36 inch prior to being wheel loaded. Replace to their original condition all turf, plants, concrete, asphalt, or other improvements which constitute landscaping, traffic areas or other improved areas which become disturbed by excavation. In graded and undeveloped areas, in addition to procedures specified above, backfill trenches with crown 8 inch above the surrounding surface.

C. Excavated and backfill in soils of unstable nature shall be provided as directed by Architect.

3.19 PIPE INSPECTIONS

A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e. "Rough-in" "Top-out" and final.
HVAC PIPING, VALVES AND SPECIALTIES

B. Inspection - Below Grade: All piping installed below grade shall be inspected prior to burial by the Architect, the Owner's Representative or the Engineer. Provide photographs of underground piping in Operation and Maintenance Manuals including location and depth of pipes. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be buried without approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

C. Inspection - Above Grade: All piping installed above grade shall be inspected upon completion and prior to finish of walls and ceilings by the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be hidden within the structure prior to inspection approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.20 PAINTING (SEE SECTION 230500)

3.21 IDENTIFICATION MARKERS (SEE SECTION 230500)

3.22 WATER ANALYSIS AND TREATMENT

A. Upon completion of systems installation, cleaning, and filling, engage a qualified water treatment firm, acceptable to the Architect and Engineer. The water treatment firm shall perform a chemical analysis on each system listed hereinafter, and shall submit to the Engineer a report, including the following:

1. Analysis of heating water, chilled water, and condenser water systems
2. Initial treatment of each system
3. Recommendations regarding subsequent, periodic, or continuous treatment on each system

B. Contractor is to furnish and install initial treatment.

C. For all systems except steam and condenser water, contractor is to provide for periodic testing at 6 months and 12 months after startup and shall provide all recommended treatment for full first year of system operation. For steam and condenser water systems provide monthly testing and report.

3.23 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The systems may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. "Tolerance" shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times (1.5x) the system operating pressure or the listed test pressure below, whichever is greater. Do not exceed the maximum pressure rating of the piping.

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>TEST MEDIUM</th>
<th>TEST PRESSURE</th>
<th>TOLERANCE – TEST PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water</td>
<td>Water</td>
<td>100 psig</td>
<td>None - 8 hours</td>
</tr>
<tr>
<td>Condenser Water</td>
<td>Water</td>
<td>100 psig</td>
<td>None - 8 hours</td>
</tr>
<tr>
<td>Tanks</td>
<td>Water</td>
<td>1.5 x working pressure</td>
<td>None - 24 hours</td>
</tr>
<tr>
<td>Heating Water</td>
<td>Water</td>
<td>100 psig</td>
<td>None - 8 hours</td>
</tr>
<tr>
<td>Steam</td>
<td>Air</td>
<td>200 psig</td>
<td>None – 8 hours</td>
</tr>
</tbody>
</table>
HVAC PIPING, VALVES AND SPECIALTIES

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>TEST MEDIUM</th>
<th>TEST PRESSURE</th>
<th>TOLERANCE – TEST PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensate</td>
<td>Water</td>
<td>150 psig</td>
<td>None – 8 hours</td>
</tr>
<tr>
<td>Refrigerant Piping</td>
<td>Air</td>
<td>200 psig</td>
<td>None – 8 hours</td>
</tr>
</tbody>
</table>

Ground Source Heat Rejection: See Section 232133.33.

D. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.

E. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, and air vents for proper performance. Test all air vent points to ensure that all air has been vented.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Close coupled end suction pumps.
   2. In-line close coupled pumps.
   3. In-line circulators
   4. Condensate return pump and receiver sets.
   5. Expansion tanks - atmospheric.
   6. Expansion tanks - diaphragm type pre-pressurized.
   7. Air separators.
   8. Air elimination valve.
  10. Chemical pot feeders.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230900: Controls and Instrumentation
D. Section 230902: Variable Frequency Drives (VFD)
E. Section 233113: Air Distribution
F. Section 233412: Air Handling Equipment
G. Section 235200: Heat Generation
H. Section 238239: Heat Transfer
I. Division 26: Electrical

1.4 QUALITY ASSURANCE
A. Manufacturer’s Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products.
B. Codes and Standards: Provide pumps which conform to the requirements of:
   1. Hydraulic Institute (HI): Manufacturer pumps in accordance with “Standards for Centrifugal Rotary and Reciprocating Pumps.”
   2. National Electrical Manufacturers Association (NEMA): Provide electrical components which comply with NEMA Standards.
      a. 70: National electrical Code
   4. Underwriters Laboratories (UL):
      a. UL-778: Motor Operated Water Pumps
1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
   1. Parallel pump plots: For all parallel and series pump applications submit a combined pump curve showing parallel pump operation and single pump non-overloaded operation verifying that the pump selections operate non-overloading on curve in a single pump operation.
   2. Submittal information to verify all scheduled characteristics are met including efficiency.

B. Shop Drawings: Submit manufacturer’s shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

D. Wiring Diagrams: Submit manufacturer’s ladder-type wiring diagrams for power and control wiring required. Differentiate between factory-installed and field-installed wiring.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer’s stamp or label affixed.

B. Store and protect products and units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

C. Rigging: Comply with the manufacturer’s rigging and installation instructions.

1.7 WARRANTY

A. Provide general one year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 CLOSED COUPLED END SUCTION PUMPS

A. Furnish and install pumps with capacities as shown on plans. Pumps shall be close coupled, single stage, vertically split case design, capable of being serviced without disturbing piping connections.

B. Pump volute shall be Class 30 cast iron, and impeller shall be cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew. Impeller trim shall be no greater than 85% of the maximum impeller size for the pump.

C. The liquid cavity shall be sealed off at the motor shaft by an internally flushed mechanical seal with ceramic seal seat of at least 98% alumina oxide content, and carbon seal ring, suitable for continuous operation at 225° F. A replaceable shaft sleeve of bronze alloy shall completely cover the wetted area under the seal.

D. Pumps shall be rated for minimum of 175 psi working pressure. Casings shall have gauge ports, and vent and drain ports at top and bottom of casing.

E. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. It shall have heavy duty grease lubricated ball bearings, completely adequate for the maximum load for which the motor is designed. Provide premium efficiency motors in accordance with Section 230500.

F. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.
PUMPS AND HYDRONIC SPECIALTIES

G. Each pump shall be checked by the contractor and regulated for proper differential pressure, voltage and amperage draw. This data shall be noted on a permanent tag or label and fastened to pump for owner's reference.

H. Manufacturer: Bell & Gossett series "1531" or approved equal by TACO, PACO, Peerless or Armstrong.

2.2 IN-LINE CLOSE COUPLED PUMPS

A. Furnish and install pumps with capacities as shown on plans. Pumps shall be in-line type, close coupled, single stage design, for installation in vertical or horizontal position, and capable of being serviced without disturbing piping connections.

B. Pump casing shall be Class 30 cast iron, and impeller shall be of cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew. Impeller trim shall be no greater than 85% of the maximum impeller size for the pump.

C. The liquid cavity shall be sealed off at the motor shaft by an internally flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225° F. A bronze shaft sleeve shall completely cover the wetted area under the seal.

D. Pumps shall be rated for minimum of 175 psi working pressure. The pump case shall have gauge tappings at the suction and discharge nozzles and will include vent and drain ports.

E. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. It shall have heavy duty grease lubricated ball bearings, completely adequate for the maximum load for which the motor is designed. Provide premium efficiency motor in accordance with Section 230500.

F. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

G. Manufacturer: Bell & Gossett series "80" or approved equal by TACO, PACO, Peerless or Armstrong.

2.3 IN-LINE WATER LUBRICATED CIRCULATING PUMPS (SECONDARY PUMPING AND BOOSTER APPLICATIONS)

A. Furnish and install pumps with capacities as shown on plans. Pumps shall be in-line type for installation in vertical or horizontal piping. Pump must be capable of being serviced without disturbing piping connections.

B. Pump body shall be of all bronze construction, rated 175 psi working pressure, with gauge ports at nozzles, and with vent and drain ports.

C. Impeller shall be non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.

D. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and carbon seal ring, suitable for continuous operation at 225° F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.

E. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans.

F. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

G. Provide H-O-A switch with overload protection. Pump shall run continuously. Wiring between switch and pump provided under Division 23, as stated in Section 230500.


2.4 CONDENSATE RETURN PUMP AND RECEIVER SETS
PUMPS AND HYDRONIC SPECIALTIES

A. General: Provide as indicated, packaged duplex condensate pump and receiver sets, of capacity as scheduled, consisting of cast-iron receiver, inlet strainer, duplex water pumps, float switches, electrical controls, and accessories.

B. Receiver: Construct of close-grained case iron. Equip with externally adjustable 2 pole float switches, water level gage, condensate thermometer, pump discharge pressure gages, bronze isolation valves between receiver and pump, and 2 lifting eye bolts. Provide isolation valve on inlet of each pump.

C. Strainer: Equip receiver inlet with cast-iron inlet strainer with self-cleaning bronze screen, dirt pocket, and clean-out plug.

D. Pump: Flange mount centrifugal water pump on receiver. Provide close-coupled pump, vertical design, permanently aligned, bronze fitted, equipped with stainless steel shaft, enclosed bronze impeller, renewable bronze case ring, and mechanical shaft seal. Provide drip-proof motor close-coupled to pump.

E. Control Panel: Provide wall mounted NEMA II control cabinet factory-wired for external electrical connection only, with hinged door and grounding lug. Provide the following within cabinet:
   1. Combination magnetic starter for each pump.
   2. Electrical alternator.
   3. Momentary contact "Test" push buttons for each pump.
   5. Fusible control circuit transformer for each circuit.

F. Control Circuits: Provide completely independent pump control circuit for each pump. Provide electrical alternator to:
   1. Change operating sequence automatically after each cycle.
   2. Provide simultaneous operation under peak load conditions.
   3. Operate idle pump automatically, should active pump or its controls fail.

G. Manufacturer: Alyn, Weil or approved equal.

2.5 EXPANSION TANKS

A. Compression Type
   1. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII, Division I of the ASME Code for a working pressure of 125 psi.
   2. Black steel construction
   3. Compression tank shall be painted with one shop coat of air dry enamel
   4. The manufacturer shall be B&G, Wessels, Amtrol or approved equal

B. Diaphragm Type Pre-pressurized:
   1. The pressurization system shall include a diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank.
   2. The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi and precharged to the minimum operating pressure.
   3. The manufacturer shall be B&G, Wessels, Amtrol or approved equal with at least five years experience in the fabrication of diaphragm-type ASME expansion tanks.

2.6 AIR SEPARATORS

A. Tangential and coalescing media type:
   1. All free air originally contained in the system, and all entrained air bubbles carried by system water shall be eliminated at all system points as indicated on the drawings.
PUMPS AND HYDRONIC SPECIALTIES

2. The air separator shall be welded steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 125 psi.
3. Air separators shall be sized as indicated on plans.
4. Provide with strainer unless otherwise noted.
5. Manufacturer: Spirovent (No Exception)
6. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and entering velocity not to exceed 4 feet per second at specified GPM.
7. Units shall eliminate 99.6% of system air (including entrained air and microbubbles). Performance curves from the unit manufacturer shall be furnished as part of the submittal for each unit. Units may include internal copper coalescing medium to facilitate maximum air elimination and suppress turbulence or be furnished with galvanized steel strainer and stainless steel collector tube for a similar purpose.
8. Provide integral high capacity float actuated air vent at top fitting of tank or cast iron float actuated air vent rated at 150 psig which shall be threaded to the top of the separator. Unit shall have bottom blow down connection.

2.7 AIR ELIMINATION VALVE (AUTOMATIC)

A. Air shall be eliminated to the atmosphere as fast as it is separated from system water, through a float activated remote pressure operated, air elimination valve installed at the top of the air separator.
B. The air elimination valve shall have a high removal rate at low pressure differentials and shall be fully open for the removal of air at all pressures in the operating range from 2 to 150 psig. It shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations.
C. The air elimination valve shall be constructed of metal and all working parts shall be non-corrosive. Working pressure shall be 125 psi.
D. Provide minimum 3/8” drain line from vent and route to nearest floor drain or floor sink or other approved drainage location.
E. Manufacturer: Amtrol, Hoffman or approved equal.

2.8 AIR ELIMINATION VALVE (MANUAL)

A. Manufacturer: B&G, Amtrol, Hoffman or approved equal.

2.9 SUCTION DIFFUSERS

A. Furnish and install as shown on plans, an angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, flow straightening vanes, start-up strainer, permanent magnet and adjustable support foot. The combination diffuser-strainer-orifice cylinder shall be designed to withstand pressure differential equal to the system pump shutoff head and shall have a free area equal to five times the cross section area of the pump suction opening. The length of the flow straightening vanes shall be no less than 2-1/2 times the diameter of the system suction connection.
B. Fitting to be of cast iron construction with flanged connections unless otherwise noted. See plan for sizes.
C. The fitting shall have a stainless steel combination diffuser-strainer-orifice cylinder with 3/16 inch diameter perforation to protect system pump. Provide with stainless steel straightening vanes. Start-up strainer to be 16 mesh bronze. All internal components to be replaceable.
D. Manufacturer: Bell & Gossett, TACO, Wheatley, Victaulic or approved equal.

2.10 CHEMICAL POT FEEDER

A. Provide five gallon pot feeder with removable cover, bottom drain valve, and shut-off valves. Provide balancing valve and check valves as shown on Drawings.
PUMPS AND HYDRONIC SPECIALTIES

B. Mount on support stand or to the wall and pipe between the supply and return piping as shown on Drawings. Provide clearance under the pot feeder for draining.

C. Manufacturer: Dearborn, Garrett-Callahan, J.L Wingert or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer’s recommended installation instructions.

B. Grouting Pump Base: For all base mounted flexibly coupled pumps fill the pump base frame with grout after completing pump/motor alignment.

C. Provide vibration isolation, inertia bases, seismic snubber, flexible pipe connections, etc., as specified in related specification sections.

D. For variable flow pumping applications, see Section 230902 for additional requirements.

E. Mechanical contractor to assist testing and balancing contractor in verifying correct pump rotation and system operation.

F. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.

G. Isolation for Service: Provide pump installations with a discrete isolation valve on both the supply and intake side of the pump to permit service of the pump and any related strainer, check or balancing valves. Triple duty valves are not equivalent for this shut-off service.

H. Balancing Coordination and Impeller Trimming: Coordinate final pump flow with test and balance contractor. For pumps larger than 5 horsepower, if the system tests and balance indicate that flow exceeds the specified flow by greater than 20%, it is not acceptable to reduce flow merely by adjusting balance valves to create additional head or reducing VFD peak flows. Excess system flow must be reduced by trimming the impeller to match the load.

3.2 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of
General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500
- Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. Includes, but not limited to:
   1. Furnish and install piping and piping specialties for refrigeration systems serving split
      system air conditioning units.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230700: Mechanical Insulation
C. Section 238126: Split Gas Furnace/Air Conditioning Units
D. Section 238145: Split Heat Pump Units
E. Division 26: Electrical

1.4 QUALITY ASSURANCE
A. Qualifications: A refrigeration contractor licensed by the State shall install refrigerant piping.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING
A. Meet requirements of ASTM B 280-88, "Specification for Seamless Copper Tube for Air
   Conditioning & Refrigeration Field Service", hard drawn straight lengths. Reflok aluminum piping
   and mechanical fittings may be considered with prior approval.

B. Do not use pre-charged/pre-insulated refrigerant lines more than 50 feet in length.
   1. Gel Copper Pre-Insulated Copper Rolls or equiv.

2.2 REFRIGERANT FITTINGS
A. Wrought copper with long radius elbows.
B. Approved Manufacturers:
   1. Mueller Streamline
   2. Nibco, Inc.
   3. Grinnell
   4. Elkhart Products Corp.
   5. PDM

2.3 SUCTION LINE TRAPS
A. Manufactured standard one-piece traps.

2.4 CONNECTION MATERIAL
A. Brazing Rods:
   1. Copper to Copper Connections:
      a. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
      b. AWS Classification BCuP-5 Copper Phosphorus (15% silver).
   2. Copper to Brass or Copper to Steel Connections
      a. AWS Classification BAg-5 Silver (45% silver)
   3. Do not use rods containing Cadmium.
2.5 FLUX
   A. Approved Manufacturers
      1. "Stay-Silv white brazing flux" by J.W. Harris Co.
      2. High quality silver solder flux by Handy & Harmon.

2.6 EXPANSION VALVES
   A. For pressure type distributors, externally equalized with stainless steel diaphragm, and same
      refrigerant in thermostatic elements as in system.
   B. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator
      coil and condensing unit.
   C. Approved Manufacturers:
      1. Alco
      2. Henry
      3. Mueller
      4. Parker
      5. Singer
      6. Sporlan

2.7 FILTER-DRIER
   A. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with non-
      ferrous casing and Schraeder type valve.
   B. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper
      fittings.
   C. Size shall be full line size.
   D. Approved Manufacturers:
      1. Alco
      2. Mueller
      3. Parker
      4. Sporlan
      5. Virginia

2.8 SIGHT GLASS
   A. Combination moisture and liquid indicator with protection cap.
   B. Sign glass shall be full line size.
   C. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses
      allowed.
   D. Approved Manufacturers:
      1. Alco
      2. Asco
      3. Mueller
      4. Parker
      5. Sporlan

2.9 MANUAL REFRIGERANT SHUT-OFF VALVE
   A. Ball valves designed for refrigeration service and full line size.
   B. Valve shall have cap seals.
   C. Valves with hand wheels are not acceptable.
   D. Provide service valve on each liquid and suction line at compressor.
REFRIGERANT PIPING SYSTEMS

E. If service valves come as integral part of condensing unit, additional service valves shall not be required.

F. Approved Manufacturers:
   1. CoBraCo (Apollo)
   2. Henry
   3. Mueller
   4. Superior
   5. Virginia

2.10 FLEXIBLE CONNECTORS

A. Provide each liquid line and suction line at both condensing unit and evaporator on systems larger than five tons.

B. Anchor pipe near each flexible connector.

C. Connectors shall be for refrigerant service with bronze seamless corrugated hose and bronze braiding.

D. Approved Manufacturers:
   1. Anaconda "Vibration Eliminators" by Anamet
   2. Vibration Absorber Model VAF by Packless Industries

PART 3 - EXECUTION

3.1 INSTALLATION

A. Slope suction lines down toward compressor or one inch/10 feet. Locate traps at vertical rises against flow in suction lines.

B. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.
   1. No soft solder (tin, lead, antimony) connections will be allowed in system.
   2. Braze valve, sight glass, and flexible connections.
   3. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

C. Insulate all suction and hot gas lines. Insulate liquid lines where pipe may be in close contact to humans.

3.2 FIELD QUALITY CONTROL

A. Make evacuation and leak tests in presence of Architect’s Engineer after completing refrigeration piping system. Positive pressure test will not suffice for procedure outlined below:
   1. Draw vacuum on each entire system with vacuum pump to 200 microns using vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum. Isolate compressor from system piping using shut-off valves prior to pulling vacuum.
   2. Break vacuum with refrigerant to be used and re-establish vacuum test. Vacuum shall hold for 24 hours at 200 microns without compressor running.
   3. Conduct test at 70°F ambient temperature minimum.
   4. Do not use systems until tests have been made and systems started up as specified. Inform Owner’s Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
   5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.
   6. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlets at same end of coil.
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Ductwork - Rigid, Flexible and Fabric
   2. Ductwork Specialties
   3. Flexible Connections
   4. Sealants, Adhesives and Tapes
   5. Flashings
   6. Bird Screens
   7. Duct Access Panels and Doors
   8. Control Dampers
   9. Backdraft Dampers
   10. Louvers
   11. Diffusers, Grilles, and Registers
   12. Fire and Smoke Dampers
   13. Sound Traps
   14. Fan Powered Terminal Units
   15. Variable Air Volume (VAV) Terminal Units
   16. Elevator Shaft Vents

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:
   1. ARI 885-98 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminal and Air Outlets."
   3. ANSI S1.23 - Designation of Sound Power Emitted by Machinery and Equipment.
   8. TIMA AAC-101 - Standard for fiberglass duct liner with erosion proof facing.

B. Conform to NFPA 90A "Standards for the Installation of Air Conditioning and Ventilating Systems".

C. Provide and construct ductwork systems in conformance with the latest editions of the following documents:
AIR DISTRIBUTION

1. SMACNA "HVAC Duct Construction Standards-Metal and Flexible - 2005"
2. SMACNA "Accepted Industry Practice for Industrial Duct Construction" for duct pressures above +5" W.G. positive pressure or below -5" W.G. negative pressure. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards.
3. ASHRAE Systems and Equipment Handbook "Duct Construction" chapter
4. ASHRAE Fundamentals Handbook "Duct Design" chapter

D. Alternatives: The SMACNA standards and publications referenced in this Section of the specifications establish ductwork construction requirements.
1. Alternatives to these standards and publications may be submitted. Approval will be based on demonstration that such alternatives are equivalent and satisfy the functional requirements described in the referenced standards.
2. Such demonstration shall include evidence that the alternatives proposed were tested in accordance with SMACNA procedures and with test results certified by an independent testing laboratory.

E. All ductwork and equipment shall be seismically supported and braced per the SMACNA “Seismic Restraint Manual: Guidelines for Mechanical Systems”.

F. Flame/Smoke Rating: All materials, including sealants and adhesives, exposed within plenum shall have a flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

1.5 SUBMITTALS

A. Prior to construction, submit for approval on all materials and equipment:
1. Ductwork - Rigid, Flexible and Fabric
2. Ductwork Specialties
3. Flexible Connections
4. Sealants, Adhesives and Tapes
5. Flashings
6. Bird Screens
7. Duct Access Panels and Doors
8. Backdraft Dampers
9. Control Dampers
10. Diffusers, Grilles, and Registers
11. Fire and Smoke Dampers - Schedule of selected dampers must include the location, nominal size, free area velocity, and static pressure drop at free area velocity for each damper.
12. Sound Traps
13. VAV Boxes
14. SMACNA "HVAC Duct Construction Standards - Metal and Flexible"

B. Shop Drawings: Provide shop drawings of sheet metal ductwork and plenums as follows:
1. Draw to a scale not less than ¼" to one foot, with sheet sizes equal to Contract Drawings.
2. Show duct sizes, where possible use even duct sizes.
3. Show fitting details.
4. Show coordination with lighting fixtures, fire dampers, smoke dampers, piping, diffusers, grilles, registers, fans, major electrical runs, cable trays and bus ducts.

C. Shop Drawings: Provide shop drawings for field erected mechanical equipment:
1. Draw to a scale of ½" to one foot, with sheet sizes equal to Contract Drawings.
2. Show plan, sections, elevations and details of all joints and enclosures.
3. Detail access doors and hardware.
4. Detail coil, damper, humidifier, filter and fan installations.
AIR DISTRIBUTION

5. Show access space for electrical components that are part of the equipment provided and/or installed such as power and control panels on humidifiers. This shall be coordinated with Division 26 and NEC.

D. Certifications: Provide a duct schedule, certified by an officer of the sheet metal fabrication subcontractor, that the ductwork conforms to SMACNA standards, and for each sheet metal system furnished on the project include:
   1. System name.
   2. Duct material.
   3. Duct gauge.
   4. SMACNA rectangular reinforcement number.
   5. SMACNA intermediate reinforcement number.
   6. SMACNA transverse reinforcement number.
   7. Rod diameter and type.
   8. Sealant type.
  10. Duct system design pressure.

E. Construction IAQ Management Plan: Collaborate with the general contractor to submit and implement an IAQ Management Plan for the construction process meeting the requirements of the SMACNA IAQ Guidelines. This plan should address the protection of the ventilation system components during construction and cleanup of contaminated components after construction is complete. SMACNA IAQ Guideline recommends control measures in five areas. The IAQ Management Plan should address how compliance has been achieved in these required five areas as follows:
   1. HVAC Protection
      a. Shutdown of return side of existing HVAC system in areas affected by heavy construction.
      b. Provision of temporary filters if existing or new systems must remain operational during construction.
      c. Dampering of supply and returns and sealing of openings in areas subject to construction dust.
   2. Source Control
      a. How will reduction of contaminants be reduced at the source?
      b. What steps will be taken to employ low emitting products and sealants.
      c. How will air handling equipment be cycled off when not needed?
   3. Pathway Interruption
      a. Describe how the construction space will be ventilated as required to dilute contaminants.
      b. Describe how occupied spaces adjacent to construction areas will be kept at positive pressure relative to spaces under construction.
   4. Housekeeping: Describe how the following housekeeping objectives will be implemented:
      a. Reduction of dust generated by work will be suppressed.
      b. Maintaining a frequent cleaning frequency for dust and particulates.
      c. Remove spills or excess applications of solvent-containing products as soon as possible.
      d. Remove accumulated water and keep work areas as dry as possible.
      e. Protect insulation materials from exposure to moisture.
   5. Scheduling: Describe how overlap of construction activity and ongoing building occupancy activities will be minimized.

F. Field Manual: Submit one copy of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible". Maintain a second copy on the project site.

G. Any ductwork installed without prior approval by the specifier, shall be replaced at the expense of the contractor.
H. The contractor must comply with the enclosed specification in its entirety. If on inspections, the specifier finds changes have been made without prior approval, the contractor will make the applicable changes to comply with this specification, at the contractor’s expense.

I. At the discretion of the specifier, sheet metal gauges, and reinforcing may be checked at various times to verify all duct construction is in compliance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer’s stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged components. Remove damaged products from project site.

PART 2 - PRODUCTS

2.1 DUCTWORK

A. Construct all ducts and plenum of gauges, and with joints, bracing, reinforcing, and other construction details in accordance with the latest construction standards previously listed. Metals shall be manufactured by United States Steel, Kaiser, Rolok or equal.

B. Duct dimensions indicated on drawings are net, inside, clear dimensions. For internally lined ducts, add lining thickness to determine metal duct dimensions.

C. Ducts shall be constructed of material gauges and reinforcement per SMACNA pressurization classifications to meet 150% of the pressure requirements for external static pressure scheduled on drawings for the fans serving each system. Where differences exist between SMACNA and the prevailing building code, the gauge or construction method of the submitted ductwork shall be the more stringent of the two standards. See also Part III Execution for matrix of materials and pressure requirements.

2.2 SHEET METAL MATERIALS

A. General Material Requirements: 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 A653/A653M.
   a. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)]
   b. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)].
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils (0.10 mm) thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil (0.025 mm) thick on opposite surface.
   3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A480/A480M, 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.

F. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:
AIR DISTRIBUTION

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 D3363.

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.

5. Shop-Applied Coating Color: Black or white.

6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. Reinforcement Shapes and Plates: ASTM A36/A36M, 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.

I. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 DUCTWORK FABRICATION

A. Joints – Sealing

1. Duct tape is not allowed. Rolled elastomeric duct sealants are not allowed.

2. Solvent-based and oil-based sealants are not allowed indoors.

3. Seal all transverse joints - this includes mechanical joints similar to Ductmate on all supply, return, exhaust and outside air intake ducts.

4. All sealant systems for outdoor application to be suitable for use in exposure to water.

5. All sealant systems for indoor application to meet VOC limits as specified in South Coast Air Quality Management District (SCAQMD) Rule #1168 limiting VOC’s to 80 gram/Liter for ductliner adhesives and 250 grams/Liter for duct sealants.

6. Manufacturers: Tremco, Dure Dyne, Hardcast, Ductmate, Mon-Eco Industries, McGill AirSeal LLC, or equal, as recommended for ductwork application.

7. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, suitable for high velocity and high pressure applications, UL 181B-M listed, UL 723 classified, and complying with NFPA requirements for Class 1 ducts.

a. Outdoor Application: Not permitted where subject to moisture exposure.

b. Indoor Application: Hardcast Iron Grip, Ductmate PROseal, Mon-Eco EZ Seal 44-44, or equal.

8. Two-Part Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermally with tape to form hard, durable airtight seal. Hardcast Two Part II, McGill Uni-Cast, or equal.

B. Joints - Rectangular Ducts

1. Slip drive joints, standard seams, flanges or welding as required by SMACNA HVAC Duct Construction Standards for system static pressure. Ductmate, MEZ Industries, or equal are acceptable joint methods, but must be sealed as described previously. Transverse joints shall be constructed per Figure 2-1 for types T-8 through T-25. T-1 and T-5 slip joints are NOT allowed. Joint T-2, T-3, T-6 and T-7 reinforced slip joints are allowed below 2” static pressures.

C. Joints - Round

1. Exposed Ductwork: Slip drive and sheet metal screws.

2. Concealed Ductwork: Sheet metal screws.

D. Elbows

1. Radius: Construct round, oval and rectangular radius elbows with centerline not less than 1.5 times the duct width. Rectangular elbows with inside radius heel are NOT allowed as these create excessive pressure drop and are not per SMACNA.
AIR DISTRIBUTION

2. Elbows: Provide single thickness turning vanes on all rectangular elbows less than 25" wide with vane spacing of 1.5". Provide double thickness turning vanes for rectangular radius elbows 25" wide and greater with vane spacing of 2.125" to 2.5". Number of vanes per SMACNA.

E. Transitions
1. Construct transitions with minimum slope of 1 to 5 ratio and in conformance to SMACNA.

F. Branch Connections
1. Provide 45° entry boots or radius taps for rectangular duct take-offs and conical or bellmouth taps for round duct take-offs. Straight 90° taps are not allowed, except where round take-off duct size equals round branch duct size. Provide volume dampers at take-offs for balancing if not specifically noted as provided at outlet or inlet. Provide insulation guards at transitions to lined ductwork.

2.4 RECTANGULAR DUCTWORK

A. Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA "HVAC Duct Construction Standards Metal and Flexible" 1995 Edition. This shall be subsequently referred to as the SMACNA Manual. All ductwork must comply with all local, code requirements. Ductwork shall be constructed of galvanized steel. Diagonally cross break all panels on ducts 30 inches wide and larger, or bead using automatic bead machine with beads at 12 inches on center or less. All connections shall utilize 45° boot take-offs. Bullhead tees and straight taps are not permitted.

2.5 ROUND AND OVAL DUCTWORK

A. Round and oval ductwork shall be constructed to SMACNA round ductwork requirements of galvanized sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Chapter 3, "Round, Oval, and Flexible Duct", based on indicated static-pressure class unless otherwise indicated. Longitudinal seams shall be spiral lock seams or continuous welded. Flat oval shall be utilized in space-restricted areas. Elbows shall be 5-piece mitered and welded. All elbows shall be long radius type with centerline radius to duct diameter of 1.5, exceptions will only be allowed at restricted space locations.

B. Round or oval duct and fitting manufacturers:
1. McGill Airflow Corporation
2. Lindab
3. Semco
4. Sheet Metal Connectors
5. Spiral Manufacturing
6. Or equal.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Figure 3-1, "Round Duct Transverse 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." All transverse joints to be externally sealed at all joints.
1. Exception: internal manufactured single or dual EPDM rubber gasket fittings do not require external sealant.
2. Transverse joints in ducts larger than 50" diameter require flanged joints.
3. Lap or snap lock seams are not permitted for round ductwork of any size.

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals,
AIR DISTRIBUTION

and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal joints shall be sealed air tight with sealant or continuous welding.

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", Figure 3-5, "45 Degree Tees and Laterals", and Figure 3-6, "Conical Tees" and "45 Degree Boot 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."

1. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted.

2.6 FLEXIBLE DUCTWORK

A. Flexible one-inch thick insulated round ductwork may be utilized where shown on the Drawings and at the last seven (7') feet to each air outlet and inlet, unless shown otherwise on the plans. Maximum of only one 90° bend in any length. Elbows in flex ductwork are to be supported using Flexmaster Item #41650 duct support. No intermediate joints are allowed. Connect each end with stainless steel screw operated drawbands. Support duct to maintain smooth shape without sagging. All connections shall utilize welded conical tees, aluminum conical fitting, Flexmaster #CB, or 45° boot take-offs by Flexmaster #STO. Spin-in type or other types of butt tees, bullhead tees or straight taps are not permitted. Dampers are to be Ventlok dampers with end bearings.

B. Flexible ductwork for low pressure systems with positive static pressure at or below 2" w.g. positive pressure shall be a trilaminate of aluminized foil, fiberglass insulation, and aluminized polyester, mechanically locked to galvanized steel helix without adhesives, exterior 1" fiberglass insulation and fire retardant plastic outer jacket. Flexmaster #Type 5B, Thermaflex Model M-KC or approved equal.

C. Flexible ductwork for medium and high pressure systems with static pressures above 2" w.g. through 10" w.g. positive pressure shall be a heavy coated fiberglass cloth fabric mechanically locked to galvanized steel helix without adhesives, exterior 1" fiberglass insulation and fire retardant plastic outer jacket. Flexmaster #Type 4B, Thermaflex Model M-KC or approved equal.

D. Flexible aluminum ductwork for use in magnetic/electrically sensitive room environments, such as MRI rooms, in low pressure systems with static pressure at or below 2" w.g. positive pressure shall be a trilaminate of aluminized foil with aluminum helix with exterior 1" aluminum jacket fiberglass insulation. Flexmaster #TL-B or approved equal.

2.7 FRP DUCTWORK FOR UNDERGROUND APPLICATION

A. Code Compliance: All duct and fittings shall be designed and constructed to meet the applicable requirements of the mechanical codes for direct burial application. These requirements include:

1. Ducts to be approved for underground installation.
2. Plastic duct and fittings described below may be utilized in underground installations only. The maximum design temperature for systems utilizing plastic duct and fitting shall be 150°F.

B. Underground ductwork, including fittings, shall be constructed of fiberglass reinforced plastic as manufactured by Spunstrand Inc. All ductwork and fittings shall include labels certifying this and shall be installed in strict accordance with the manufacturer's instructions.

1. Resin - The resin used shall be isophthalic polyester, tested and approved to meet requirements for underground installation and suitable for corrosion against all normal soil and moisture conditions.
2. Inner Lining - All duct and fittings shall have a UL listed Class 1 inner liner for both flame spread and smoke developed ratings.
3. Structural Layer - The structural layer shall be filament wound of resin and glass to meet the specified working pressures and depths of burial requirements.
AIR DISTRIBUTION

4. Insulation – Insulation shall be closed cell polyisocyanurate foam that is 5/8" thick, R-5.
5. Fittings - Fittings shall be fabricated from straight duct and have the same working pressure and will also be corrosion and moisture resistant.
6. Reducers shall be filament wound as specified for the duct.

C. Joints - Field joints are to be watertight by using an internal aluminum sheet metal sleeve secured with sheet metal screws. The joints shall then be of the wet lay-up type in strict accordance with the manufacturer’s instructions. This includes thoroughly cleaning and sanding areas to be joined and using polyester resin and fiberglass mat. See wet lay-up joint instructions.

D. Underground ductwork shall be factory pre-insulated including all fittings. The duct shall be I.C.B.O. listed and installed in strict accordance with the manufacturer’s instructions.

2.8 ACOUSTICAL DUCT LINER

A. Acoustic Duct Lining shall be installed where shown on the drawings and as specified for low velocity supply, return and exhaust ductwork. Liner is to be utilized to line vertical supply duct risers, mechanical shafts conveying return air, terminal box discharge plenums, and other horizontal duct runs where shown on drawings. Dimensions of lined ducts given on the drawings indicate the inside dimensions of duct after the lining has been installed. Black-coated (vinyl, acrylic or neoprene) duct lining shall be adhered by 100% covering of a fire retardant adhesive (3M EC-1128, Benjamin-Foster 85-20, or equal). When width of duct exceeds 12" and also on sides when height exceeds 24", use non-ferrous mechanical fasteners such as welded pins and speed clips, 12" on center maximum lateral spacing and 18" on center maximum longitudinal spacing. Start fastening within 3" of upstream transverse edge of the liner and within 3" of the longitudinal joint. Mechanical fasteners shall not pierce the duct walls. The pins shall be cut off flush, washers shall be used and installation made so that no gaps or loose edges occur in the insulation. Apply a brushcoat of Benjamin-Foster 30-36 to washers, extending onto lining surface a minimum of 2". Top pieces shall be supported by the side pieces. Provide insulated build out frames for attaching dampers at running vanes where required.

B. All transverse and longitudinal abutting edges of duct lining shall be sealed and lapped 3" with a heavy coat of Foster 30-36, in accordance with the manufacturer's recommendations. All exposed edges shall be installed with sheet metal nosings. At all openings in the ductwork there shall be a galvanized metal flange, equal in depth to adjacent lining and having a 1½" lip to hold lining in place. All bolt holes shall be sealed airtight.

C. Internal Duct lining shall be installed in complete accordance with the Sheet Metal and Air-Conditioning Contractors National Association (SMACNA) Duct Lining Application Standard. Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1 from SMACNA. Adhesive shall be water-based and conform to Adhesives and Sealant Council Standards for Adhesives for Duct Liner ASC-A-7001C.

D. Internal Duct Lining shall be 1" unless otherwise called out, matte-faced, 1.5 lb/ft³ minimum density and shall meet the requirements of NFPA90-A.

E. Acoustical duct liners shall comply with the following requirements and standards:
   1. ASTM C 1071, Type 1.
   2. NFPA 90A and 90B.
   3. Resist fungal growth.
   4. Support air velocities up to 5,000 fpm.
   5. Per UL 723 test method, flame spread shall not exceed 25, and smoke developed shall not exceed 50.
   6. Per test method ASTM C423 using Type A mounting, minimum allowable NRC shall be 0.45.
AIR DISTRIBUTION

F. The following are acceptable, subject to the above:
   1. Internal Duct Lining:
      a. Aeroflex Type 150 from Owens-Corning Fiberglass, Toledo, OH.
      b. Linacoustic/Spiracoustic Type 150 from Manville Products Corp., Denver, CO.
      c. Ultralite Type 150 from Certain Teed Corp., Valley Forge, PA.
      d. Pre-approved equal to above.

   2. Mechanical Fasteners:
      a. Gemco TYPE IH-A from Goodloe E. Moore, Inc., Danville, IL.
      b. Eckoustic-Klip from Eckel Industries, Inc., Cambridge or MA.
      c. Pre-approved equal to above.

2.9 DUCT/VAV UNIT SOUND CONTROL LAGGING

A. Where indicated on the drawings, VAV unit or duct shall be wrapped with minimum 2” thick glass or mineral fiber blanket, 1.5 lb/ft³ minimum density and two layers of “mass-loaded” vinyl sheet. Each lead vinyl sheet shall weight 0.4-0.5 lb/ft² and shall be 0.025 - 0.040 inches thick. The lead vinyl shall be applied to the fiber base fabric with edges overlapped by at least 2 inches and sealed with duct tape. Complete system or lead/vinyl material shall provide a minimum STC-20 as measured in an independent accredited acoustical laboratory in accordance with ASTM E90 and/or E413.

B. The following are acceptable:
   2. Soundfab from The Soundcoat Company, Inc., Santa Ana, CA.
   3. EAR WB-5 from EAR Corporation, Indianapolis, IN or approved equal.

2.10 PLENUMS AND EQUIPMENT CASINGS

A. Construct casings and plenums in conformance with SMACNA.

B. Minimum Pressure Class: Unless otherwise indicated construct plenums and casings to withstand either a negative or positive static pressure of 4” W.G.

C. Single-Wall: Provide single-wall, casings and plenums where indicated on the drawings.
   1. Construct in accordance with SMACNA Standards.
   2. Use steel-angle-reinforced standing-seam construction.
   3. Locate intermediate bracing angles bolted to the casing 24 inches on centers.
   4. Construct for static pressure indicated or for the maximum fan static pressure whichever is less.
   5. Bolt to 3” high concrete pads using 1½” x 1½” x ¼” thick galvanized steel structural sections.

D. Double-Wall: Provide where indicated on the drawings, constructed as follows:
   1. Provide 4” thick prefabricated double wall insulated metal panel assemblies, with 16MS gauge aluminum or 18 gauge minimum galvanized steel outer sheets.
   2. Provide 22 gauge Type 304 stainless steel inner sheets.
   3. Casings shall be fully metal enclosed, insulated with 4” thick rigid fiberglass insulation and conforming to NFPA 90A, with maximum flame spread of 25 and maximum smoke developed of 50.
   4. Field or factory fabricate to size and configuration indicated on the drawings, using field verified dimensions.
   5. Provide coordinated shop drawings.
   6. Reinforce spans 10’ or greater with structural steel sections to yield maximum deflection ¼” at minus 10” or plus 10” W.G. static pressure.
   7. Provide openings and doors, all factory framed, and reinforced with 304 stainless steel structural sections.
   8. Construct doors of same material as casings, of sizes and locations indicated on the drawings but not smaller than 18” by 54”, and conforming to SMACNA.
   9. Provide doors, hinges and hardware factory fabricated and mounted.
   10. Door swings shall open against air pressure, with door latches operable from either side.
AIR DISTRIBUTION

11. Provide door seals with neoprene gaskets, which have an airtight seal.
12. Provide each door with a 10" by 10" wire reinforced double pane window.
13. Bolt base channel to 3" high concrete pads.

2.11 DUCTWORK SPECIALTIES

A. General: Where specifically called for, materials for use in fabricating ductwork specialties shall be identical to that used to fabricate ductwork. See drawings and Part 3, Execution for schedule.

B. Volume and Splitter Dampers: Galvanized sheet metal blade and frame with Ventfabs Inc., Ventlok operating hardware. For accessible dampers, provide #641 self-locking dial regulators and #644 self-locking dial regulators for insulated ductwork, #637 square end bearing, and #635 spring end bearing, as applicable. For inaccessible dampers, provide #666 or #677 concealed locking damper regulator with bearings as above. For static pressures above 3" W.G., provide #640 Hi Vel dial regulator and #609 Hi Vel end bearing for accessible dampers. Regulators shall extend to and through ceiling with neatly installed hardware at the finished ceiling. For inaccessible dampers requiring adjustment through diffusers use Young Regulator, Bowden cable control system.

C. Multi-louver Volume Dampers: 16 gauge galvanized steel frame. Opposed, 6" wide, 16 gauge galvanized steel blades. Concealed linkage in frame. Ruskin #CD35/OBD or equal.

D. Flexible Connections: Provide flexible connectors at the discharge and inlet of fans, air handlers, rotating mechanical equipment, and where shown on the Drawings for proper vibration isolation. Neoprene impregnated glass cloth with 24 gauge galvanized metal frame. Neoprene-only connectors are not allowed. Minimum dimensions - 3" metal, 3" fabric, 3" metal. Ventfabs #Ventglas or approved equal by Duro Dyne, Q Industries, consolidated Kinetics, Ductmate Proflex or Elgen.

E. Ducts through roof shall be 16 gauge (or minimum of 2 gauges heavier than attaching ductwork), flashed and counterflashed, and provided with storm collars to secure a watertight construction.

F. Bird Screens: 14 gauge, ½", galvanized wire mesh, set in a galvanized steel frame, screw set.

2.12 DUCT ACCESS PANELS AND DOORS

A. In sheet metal work, hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 24" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use Ventlok or approved hinges and latches on all doors; 100 Series hinges and latches on low pressure system doors up to 18" maximum dimension, 200 Series on larger low pressure system doors and 333 Series on high pressure systems. Construct doors up to 18" maximum dimension with one inch overlap fit and gasket with ½" by ¼" sponge rubber, fit larger doors against 1½" by ¼" flat stock or angle frame and gasket with ¾" by ¼" sponge rubber or felt. Door swing to be opposite airflow. CESCO, Vent Products, Air Balance, Ductmate Sandwich or equal. Access doors smaller than 12" x 12" can be used for visual inspection of dampers, etc. on small ductwork less than 12" wide but must be of maximum size that will fit on duct with 6" x 6" as minimum size. All access doors smaller than 12" x 12" must be approved by Engineer for the specific application prior to ordering.

2.13 CONTROL DAMPERS

A. General: Low leakage dampers are to have a maximum leakage rate of 3 cfm/ft² at 1.0 in w.g. pressure difference when tested to AMCA Standard 500.

B. Damper Type One: Airfoil Low Leakage Dampers
   1. Application: Commercial supply, return, and general exhaust air systems up to 3,000 fpm velocity.
   2. Frames to be 5" x 1" x 16 gauge steel channel
   3. Blades to be 6" wide, 14 gauge galvanized steel design.
   4. Axles to be ½" diameter plated steel.
   5. Bearings to be stainless steel sleeve type pressed into frame.
AIR DISTRIBUTION

6. Linkage to be concealed in frame
7. Crank lever for operator to be provided.
8. Provide with mill finish on blades and frame.
10. Flexible metal jamb seals.
11. Maximum temperature rating to be 300°F.
12. Edit options as applicable
   Required Options:
   a. Damper position indicator switch

13. Manufacturer: Ruskin #CD60, Swartout, NCA PBD/OPD-AF-101, American Warming, Air Balance, Greenheck or approved equal.

C. Damper Type Two: Airfoil low Leakage for coastal environments.
1. Application: Commercial supply, return, and general exhaust air systems where damper will be exposed to damp marine air and where velocity is less than 3,000 fpm.
2. Frame to be 5" x 1" x 0.125 extruded aluminum
3. Blades to be 6" wide, 6063-T-5 aluminum at approximately 6" centers, opposed blade design.
4. Seals to be PVC coated polyester on blade edges, suitable for -25°F to +180°F. Jamb seal to be flexible metal compression type.
5. Bearing to be molded synthetic.
6. Linkage to be exposed on larger units and concealed on units under 14" high.
7. Axles to be ½" plated steel hex.
8. Control shaft to be ½" diameter. Outboard support bearing to be supplied with all single section dampers for field mounted operators. Factory installed jackshaft supplied on multiple section dampers.
9. Unit to meet leakage rate of 5 cfm/sf at 3" W.G. when tested in accordance with AMCA Standard 500.
10. Manufacturer: Ruskin #CD50, Swartout, NCA ACD-56-OB, American Warming, Air Balance, Greenheck or approved equal.

D. Damper Type Three: Heavy Duty
1. Application: Velocity over 3,000 fpm and fan outlet damper.
2. Frames to be 10" x 2" x 12 gauge steel channel.
3. Blades to be 7¾" wide, 0.080 thick extruded aluminum airfoil design.
4. Axles to be ¾" diameter plated steel.
5. Bearings to be stainless steel sleeve type pressed into frame.
6. Linkage to be out of airstream with 10 gauge galvanized steel clevis type arms on 7/8" diameter brass trunnions at 3" radius. Tie bar to be ¾" diameter plated steel.
7. Crank lever for operator to be provided.
8. Provide with mill finish on blades and frame.
9. Maximum temperature rating to be 300°F.
10. Edit options as applicable
   Options:
   a. Silicone rubber blade seals.
   b. Flexible stainless steel jamb seals.
   c. Bearings with integral shaft seals.
   d. Bearings bolted to frame.
   e. Bolt holes in frame.
   f. Special finishes.
   g. Electric or pneumatic operator.
11. Manufacturer: Ruskin #CD102, Swartout, American Warming, Air Balance, Greenheck or approved equal.

E. Damper Type Four: Airfoil Low Leakage Insulated Dampers
1. Application: Natural Ventilation inlets and outlets.
2. Frames to be steel or aluminum channel thermally broken with insulation within frame channels.
AIR DISTRIBUTION

3. Blades to be 6” wide, Insulated (½” polystyrene), airfoil shaped, galvanized steel double skin construction of 14 gauge equivalent design.

4. Blade Seals: Extruded silicone rubber with flexible metal compression type jamb mating seal.

5. Axles to be ½” diameter plated steel.(Optional stainless steel)

6. Bearings to be synthetic sleeve type pressed into frame.

7. Linkage to be concealed in frame.

8. Crank lever for operator to be provided.

9. Provide with mill finish on blades and frame.

10. Maximum temperature rating to be 300°F.

11. Edit options as applicable Required Options:
   a. Damper position indicator switch.

12. Manufacturer: Greenheck Model ICD-45, Ruskin #CD40x2, TAMCO Series 9000 BF, or approved equal performance insulating damper.

2.14 BACKDRAFT DAMPERS

A. Damper Types:

   1. Heavy Duty Backdraft Dampers: Provide counterweight type complete with frame, end bearings, counterbalance assembly, blades, and linkage. Pressure drop to be no more than 0.24” w.g. at 1000 fpm. Install at outside air intakes, exhaust outlets, and where shown on Drawings. Pacific Air Products #PRD-100AL, Ruskin #CBD2, NCA, or equal by Swartout, American Warming or Vent Products.


B. Application Requirements:

   1. Generator Discharge Damper: Heavy Duty Backdraft Damper. Size at no more than 1000 fpm velocity.

   2. Outside Air Intakes except where a control damper is required – Heavy Duty Backdraft Damper.

2.15 LOUVERS

A. Louvers are generally to be provided under Division 10. Where louvers are not covered on architectural plans and specifications, contractor is to provide under the following specification:

   1. Louvers to be 6” deep, 35° drainable fixed blade design, constructed of galvanized steel or extruded aluminum, or as specified on the plans.

   2. Frames to be constructed of 6” deep channel.

   3. Provide with ½” x ½” galvanized mesh birdscreen mounted on backside of louver.

   4. Finish/color per architect/engineer's review.

   5. Manufacturer: American Warming, Industrial Louver, Vent Products, NCA, Swartout, Ruskin ELF6375DX Louvers & Dampers or equal.

2.16 DIFFUSERS, GRILLES AND REGISTERS

A. All diffusers, grilles, and registers shall be selected to provide proper air distribution for the intended occupant application. All supply air devices shall be selected to provide a maximum air velocity of 50 fpm at three feet above the floor, unless otherwise noted. Manufacturer's representative shall carefully review Architectural and Mechanical drawings and ensure diffuser/grille/register selections will provide proper air distribution at NC 25 or less. Manufacturer at no additional expense to the Owner shall replace diffusers, grilles, and registers not providing proper distribution or excessive noise at scheduled airflow.

B. All frames shall be selected to fit the ceiling type. Verify with Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper where individual duct mounted balancing dampers are not provided.
C. Specialized Heating/Cooling Displacement Diffuser: Provide displacement diffusers with dual heating/cooling characteristics per the scheduled product as follows:

1. Construction: The diffuser shall be constructed with two separate plenums, one for the heating operation and one for the cooling operation. The cooling section of the heat-cool lay-in displacement diffuser shall be constructed with an equalization baffle behind the operative diffuser faces for uniform, low velocity, distribution of supply air. Both the equalization baffle and faces shall be securely retained in the diffuser frames. Plastic nozzle arrays or any plastic components are unacceptable. The diffuser frames shall be constructed of steel and shall be welded to ensure rigidity and positioning of the baffle. There shall be no visible fasteners on the front or side panels. The operative face shall be constructed of painted 18 gauge perforated steel, and the frame shall be constructed of 20 gauge steel. The internal baffling elements shall be constructed of Aluminum. The plenum may be satin coat steel. The paint shall be powder coat polyester. Epoxies and their derivatives are unacceptable. Visible non-metallic components are unacceptable. Mounting/Fastening: The diffuser shall be installed within the supplied installation frame. The diffuser shall have no visible fasteners or framing, and shall be held within the supplied installation frame via secure mounting clips.

2. Actuator: Electric Actuator: Thermal Actuator: The diffuser shall use a wax actuator controlling a damper allowing two separate air flow paths. The actuator shall close the heating section when in cooling mode and the supply temperature lowers below 70°F (21°C). The actuator shall close the cooling section when in heating mode and the supply temperature rises above 80°F (27°C). The actuator shall remain accessible from the outside of the diffuser for servicing and shall require no wiring or power by others. Mounting/Fastening: The diffuser shall be installed within the supplied installation frame. The diffuser shall have no visible fasteners or framing, and shall be held within the supplied installation frame via secure mounting clips.

D. Sizes, capacities and patterns shall be as shown on the Drawings. Manufacturer: Metal Aire, Titus, Krueger, Anemostat, Carnes, Price or Tuttle&Bailey.

2.17 DUCT SMOKE DETECTORS (DSD)

A. Duct mounted photoelectric smoke detector. One required for each heating or cooling system supplying air in excess of 2,000 cfm, for systems serving more than one occupancy type, and for control of each combination fire/smoke damper when not controlled by Div. 26 area wide detection system. Coordinate with Div 16. work and electrical installer for power to smoke detector. Detector shall be mounted in the supply air ductwork downstream of the air handler and filters, or upstream of combination dampers. Coordinate with control installer to assure that detector shall shut down the air-moving equipment when smoke is detected and close associated damper actuator(s). Sensor shall be selected to operate with air velocity rating from 100 to 4000 fpm. Provide with metal sampling tube. Provide remote test and reset station at ceiling or as otherwise indicated. Duct smoke detector shall be installed in compliance with the applicable mechanical or building code. Coordinate with Section 230900 and 230593 work. System Sensor #D2 series or approved equal.

B. Additional requirements for duct smoke detectors include requirements per Section 6.4 of NFPA-90A. Provide one duct smoke detector at each story to the connection to a common return and prior to any recirculation or fresh air inlet connection in air return systems having a capacity greater than 15,000 cfm and serving more than one story.

2.18 FIRE AND SMOKE DAMPERS

A. General:
1. Provide UL labeled 3 hour rated fire dampers at 3-hour and greater penetrations.
2. Provide UL labeled 1½ hour rated fire dampers for 2-hour and 1-1/2 hour penetrations.
AIR DISTRIBUTION

3. All dampers to be certified under the latest UL Standard. Certification based on former non-current standards is unacceptable.

4. All damper installations to conform with NFPA 90A and manufacturer's installation instructions. Details on plans are shown for reference only.

5. Install in ducts passing through walls, floors, and ceilings as required by code. Refer to Architectural and Mechanical plans for damper locations.

6. Provide fire and fire/smoke dampers in locations as required by code.

7. Provide sleeves, slip joints, retaining angles, duct access doors, ceiling access panels, etc., as required to check and service the fire dampers. Slip or break away joints are not allowed to be taped or sealed. Access doors shall be tight fitting hinged or sliding and shall have 1" high label reading "FIRE DAMPER" or "FIRE/SMOKE DAMPER".

8. All dampers to be designed for use in dynamic systems.

9. Dampers shall be rated for Leakage Class I. Leakage Class II may be used if damper size is smaller than available Leakage Class I dampers.

10. Dampers shall be certified for use by State and local authorities. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error. Do not install actuators in area where moisture can penetrate actuator or where temperature exceeds 120°F.

12. All fire dampers shall be sized to provide equivalent free area through the damper equal to the connecting ductwork, or larger. Upsize fire damper in no case is the damper pressure drops to exceed 0.25" w.g., but ideally less than 0.10" w.g., as designed for in total system static pressure allowance. See also submittal requirements in Part One of this section.

B. Radiation Ceiling Fire Dampers: Bladed ceiling fire damper constructed and tested in conformance with UL-555 (dynamic rating). Fire damper shall have a 165°F fusible link. Installation shall be in accordance with damper manufacturer's instructions. Provide fire blanket where required to obtain listed fire rating. Ruskin #CFD Series, Pottorff #CFD-15 Series or approved equal by CESCO, Air Balance, or Greenheck.

C. Dynamic Fire Dampers: Curtain fire damper constructed and tested in conformance with UL-555C. Fire damper shall have a 165°F fusible link. Fire damper shall be equipped for vertical penetrations with manufacturer supplied sleeve. Installation shall be in accordance with damper manufacturer's instructions. Curtain damper shall not be located in air stream during system operation, Style B or C. Clear inside opening through fire damper is to match clear inside opening of duct. Fire dampers in lined ducts are to match size of sheet metal duct. Provide duct and ceiling access panel as required. Ruskin#DIBD Series, Pottorff #VFD-10 Series and #VFD-30 Series, or approved equal by Air Balance, Greenheck or CESCO.

D. Combination Fire/Smoke Dampers:

1. General Requirements:
   a. Install at rated corridor wall or ceiling penetrations, occupancy separation walls, area separation walls and where shown on plans. Low leakage fire/smoke damper (Leakage Class 1 unless otherwise stated below) with electric actuator. Actuator shall be attached to sleeve outside of air stream. Fire/Smoke damper shall be equipped for vertical wall penetrations with manufacturer supplied sleeve and fail closed on loss of power. Each damper shall be equipped with a controlled 15 second electric heat-actuated release device. This device is to be equipped with a push-button reset. No manual fusible links are permitted. Manufacturer shall provide factory assembled sleeve of 16” minimum length. Installation shall be in accordance with damper manufacturer's instructions. Coordinate power and smoke detector connections with electrical installer. Integral smoke detection and actuating devices may be used if listed and approved for such service. Comply with building code requirements. All combination smoke and fire dampers shall automatically reset from closed to open position upon the reapplication of power to actuators.
AIR DISTRIBUTION

b. Actuators: All gear and housing shall be steel. The actuator shall be direct coupled and employ a steel toothed cold-weld clamp for connecting to damper shafts. Aluminum clamps or set-screw attachments are not acceptable. Actuator shall be UL listed and manufactured under ISO 9001 quality control.
   1. Actuator shall carry a manufacturer’s 5-year warranty.
   2. Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible. Actuator shall be incapable of burning out if stalled before full rotation is reached.
   3. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking, bowing, or other installation error.
   4. Actuator shall have UL555S Listing by the damper manufacturer for 350°F and be rated for 20,000 cycles minimum. Actuator shall draw no more than 0.23A at 120V running, or 0.1A holding at 120V (27 VA and 10 VA respectively for 24V power) for 70 in-lb torque.
   5. Stall and instantaneous type actuators are not acceptable.
   6. Do not install in area where moisture can penetrate damper or actuator nor where actuator temperature exceeds 120°F.
   7. All smoke and combination fire and smoke dampers shall be provided with Belimo Aircontrols FSNF120 (-S), FSNF24 (-S) actuators, or approved equal.
   8. If a Honeywell ML-4115 actuator is submitted as an alternate, it must be provided with a time delay relay to cause the actuator to reset to drive open mode on momentary loss of power for less than 3 seconds.

2. Dampers for Low Velocity Applications (2000 fpm or below):
   a. Fire damper shall have 6” wide galvanized steel blades with silicone rubber edge seals.
   b. Pressure drop of a typical 24” x 24” size damper shall be no more than 0.05” w.g. at 1000 fpm velocity.
   c. Basis of Selection: Ruskin #FSD-37, Ruskin #FSD-60, Ruskin #FSD60FA, Pottorff #FSD-140 Series, Pottorff #FSD-150 Series, or approved equal by Greenheck, CESCO or Air Balance.

3. Dampers for High Velocity Applications (2001 fpm or above):
   a. Identical to above except, fire damper shall have 6” wide galvanized steel airfoil blades with silicone rubber edge seals.
   b. Pressure drop at 2000 fpm velocity to be no more than 0.08” w.g. for a 24” x 24” size.
   c. Basis of selection to be Ruskin FSD 60 with airfoil blade, Pottorff FSD-151, or approved equal airfoil damper by Greenheck, CESCO or Air Balance.

4. Dampers for Ceiling Application:
   a. Where indicated on plans install at rated corridor ceiling penetrations.
   b. Integral smoke detection and actuating devices may be used if listed and approved for such service.
   c. Basis of Selection: Ruskin #FSD36-C, Pottorff #FSD-172, CESCO CFSD-21, Greenheck CFSD, or approved equal by Air Balance.

5. Required Options:
   a. Provide a test module to permit test cycling of the damper/actuator in the field
   b. Provide integral smoke detector OR
   c. Provide and field install smoke detector. Electrical installer shall wire.
   d. For exposed wall applications provide matching wall grille to maintain appearance and fire rating.

2.19 AIR BLENDERS

A. Prove air blenders of size as shown on Drawings, constructed of heavy gauge aluminum, all welded. Units shall be factory constructed and tested, and installed in accordance with manufacturer’s recommendations. RM Products Co. or equal.
2.20  SOUND TRAPS

A. Sound traps shall be I.A.C., Vibro-Acoustics, Aerosonics, United McGill, Transonics, Ruskin, or approved equivalent. Sound traps shall be sized for a maximum air pressure drop and maximum air velocity as noted on schedule.

B. Materials
1. Outer casings of rectangular silencers shall be made of 22 gauge type #G-90 lock-former-quality galvanized steel.
2. Interior partitions for rectangular silencers shall be not less than 26 gauge type #G-90 galvanized lock-former-quality perforated steel.
3. Filler material shall be as indicated on the Schedules and as appropriate for the application:
   a. Standard fill: Filler material shall be inorganic glass fiber of a proper density to obtain the specified acoustic performance and be packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be inert, vermin- and moisture-proof.
   b. Encapsulated fill for hospital or clean room applications: Filler material shall be inorganic glass fiber of a proper density to obtain the specified acoustic performance and be packed under not less than 5% compression to eliminate voids due to vibration and settling. Material shall be inert, vermin- and moisture-proof. Filler material shall be totally encapsulated and sealed with polymeric film of an appropriate thickness. The encapsulated fill material shall be separated from the interior perforated baffles by means of a noncombustible, erosion resistant, factory-installed, acoustic stand-off. It shall not be acceptable to omit the acoustic stand-off and try to compensate for its absence by means of corrugated baffles.
   c. Packless sound traps: No sound absorptive material of any kind is to be used in the silencers. The silencers shall attenuate air/gas transmitted noise solely by virtue of controlled impedance membranes and broadly tuned resonators.
   d. “Green” fill alternate: Acoustic fill material shall be 100% environmentally friendly, and constructed of recycled natural fibers. Each fiber shall be treated with an EPA registered fungal inhibitor in order to prevent mold, mildew, fungi, and pest protection. The fill material must not contain any harmful chemicals, irritants, and/or volatile organic compounds (VOCs) in order to prevent off-gassing.

C. Construction
1. Units shall be constructed in accordance with the ASHRAE Guide recommendations for high pressure duct work. Seams shall be lock formed and mastic filled. Rectangular casing seams shall be in the corners of the silencer shell to provide maximum unit strength and rigidity. Interior partitions shall be fabricated from single-piece, margin-perforated sheets and shall have die-formed entrance and exit shapes so as to provide the maximum aerodynamic efficiency and minimum self-noise characteristics in the sound attenuator. Blunt noses or squared off partitions will not be accepted.
2. Attachment of the interior partitions to the casing shall be by means of an interlocking track assembly. Tracks shall be solid galvanized steel and shall be welded to the outer casing. Attachment of the interior partitions to the tracks shall be such that a minimum of 4 thicknesses of metal exist at this location. The track assembly shall stiffen the exterior casing, provide a reinforced attachment detail for the interior partitions, and shall maintain a uniform airspace width along the length of the silencer for consistent aerodynamic and acoustic performance. Interior partitions shall be additionally secured to the outer casing with welded nose clips at both ends of the sound attenuator.
3. Sound attenuating units shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge from inside to outside the casing. Airtight construction
AIR DISTRIBUTION

shall be provided by use of a duct sealing compound on the jobsite material and labor furnished by the contractor.

D. Acoustic Performance
1. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM Specification E477-99. The test facility shall be NVLAP accredited for the ASTM E477-99 test standard. Data from a non-accredited laboratory will not be acceptable. The test setup and procedure shall be such that all effects due to end reflection, directivity, flanking transmission, standing waves, and test chamber sound absorption are eliminated. Acoustic ratings shall include Dynamic Insertion Loss (DIL) and Self-Noise (SN) Power Levels both for FORWARD FLOW (air and noise in same direction) and REVERSE FLOW (air and noise in opposite directions) with airflow of at least 2000 fpm entering face velocity. Data for rectangular and tubular type silencers shall be presented for tests conducted using silencers no smaller than the following cross-sections:
   a. Rectangular, inch: 24x24, 24x30, or 24x36, and
   b. Tubular, inch: 12, 24, 36, and 48

E. Aerodynamic Performance
1. Static pressure loss of silencers shall not exceed those listed in the silencer schedule as the airflow indicates. Airflow measurements shall be made in accordance with ASTM specification E477-99 and applicable portions of ASME, AMCA, and ADC airflow test codes. Tests shall be reported on the identical units for which acoustic data is presented.

2.21 VARIABLE AIR VOLUME TERMINAL UNITS

A. Furnish and install variable volume zone boxes of the sizes and capacities shown on the Drawings.

B. The control assemblies shall be pressure independent and shall be able to be reset to any airflow between zero and maximum scheduled CFM. The valves shall be normally open. The differential static pressure of the basic assembly shall not exceed 0.25" W.G. for all sizes with inlet velocities of 2,000 FPM or less.

C. The air valve shall be galvanized steel or die cast aluminum; damper shafts shall operate in rustproof Delrin or equal, self-lubricating bearings. The air valve shall seat against durable gaskets and not exceed a 2% leakage rate per ARI standards.

D. The control device shall be designed to maintain constant flow regardless of inlet flow deflection. Duct inlets at 90° or less to the control device shall not alter the maximum or minimum factory setting by more than 10%. The assembly shall incorporate a multi-point averaging differential pressure sensor mounted on the inlet.

E. The assemblies shall be contained in a welded 26 gauge galvanized steel box internally lined with ½ inch, 1½ lb. insulation complying with NFPA 90A and UL 181 standards.

F. Acoustical lining is to be a scrim reinforced foil laminate using flexible 1½ lb. density insulation meeting the requirements of UL 181 and NFPA 90A. All edges are to be sealed from the airstream, and metal brackets used to secure discharge edges on single duct terminals. For acute care facilities or surgery centers the inside surface of terminal units shall be galvanized sheet metal for a cleanable surface.

G. Fabricate and install 5 foot (minimum) acoustically lined sheet metal discharge plenum on all air terminal units. Discharge plenum shall be mounted downstream of reheat coils where applicable. Inside dimension of plenum shall be 2" larger in height and 4" larger in width than the outlet of the air terminal unit or reheat coil, whichever is greater. Refer to detail on plans for additional information. This is required for acoustic noise dissipation.

H. Hot Water Coil: Where scheduled on drawings, provide a single or double row hot water heating coil with aluminum fins mechanically bonded to copper coils. Coil velocity shall not exceed 700 FPM and static pressure loss shall not exceed .35" w.g. for a double row coil or 0.20" w.g. for a single row coil. Coil shall be pressure tested to 200 PSIG. Coil section to be based on 180°EWT
AIR DISTRIBUTION

and 140°F LWT unless otherwise noted on schedule. Maximum water pressure drop shall be limited to 5 feet w.g. unless otherwise noted.

I. Electric Coil: Terminal manufacturer to factory install coil. Coil to be UL listed. They shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5" to prevent damage to elements during shipping. Elements shall be derated nickel chrome, supported by ceramic isolators a maximum of 3.5" apart, staggered for maximum thermal transfer and element life and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety device. Provide a primary automatic reset thermal cutout, a manual reset secondary thermal cutout, line fusing, mercury contactors per element, differential pressure airflow switch for proof of flow, and line terminal block. Coil shall be capable of operating under continuous duty at 120°F discharge temperature. Unit shall include an integral door interlock type disconnect switch which will not allow the access door to be opened while power is on. Coils 4kw to 8kw shall be 2 stage, 8kw and larger shall be 3-stage. Coordinate final voltages with Div. 26.

J. Controls to be direct digital. Provide boxes without operator. Provide factory mounted low voltage transformer of sufficient capacity to power the DDC controls. Coordinate control with temperature Control Contractor. Provide factory mounted operator and thermostat control if not provided by Control Contractor.

K. Manufacturer: Titus ESV-3000, Price SDV, Trane VC, Enviro-Tec SSD, Carnes AV, Tuttle & Bailey SDV, Nailor 3000, or approved equal by Krueger or Anemostat.

2.22 FAN POWERED BOXES

A. Furnish and install fan powered boxes of the type, sizes and capacities shown on the Drawings.

B. Casing: 22 gauge galvanized steel with rectangular discharge with slip and drive type connection. One piece aluminum backdraft damper provided on fan discharge. Damper factory set and aligned for precise seal. Leak rate 2% at 0.5 WG.

C. Acoustical lining is to be standard ½", 1½ lb. insulation complying with NFPA 90A and UL-181 standards. All exposed edges shall be coated with NFPA 90A approved sealant to prevent entrainment of fibers in the air stream.

D. Acoustical lining is to be a scrim reinforced foil laminate using flexible 1½ lb. density insulation meeting the requirements of UL 181 and NFPA 90A. All cut edges are to be sealed from the air stream, and metal brackets used to secure discharge edges on single duct terminals. Titus “Fiber Free or equivalent.

E. Acoustical lining is to be a non-porous liner using 4 lb. density insulation meeting the requirements of UL 181 and NFPA 90A. All cut edges are to be sealed from the air stream, and metal brackets used to secure discharge edges on single duct terminals. Titus Fiber Free or equivalent.

F. Air Valve: Galvanized steel or cylindrical die cast aluminum airflow control device. Valve tapered to fit standard round flexible duct diameters. Normally open sequencing for reverse acting thermostat. Leak rate 4% at 2 WG. Integral flow ring taps, calibration chart for flow measurement, ±10% accuracy regardless of inlet condition.

G. Fan: Fan style galvanized steel wheel. Housing is 18 gauge steel and fan board is 16 gauge steel.

H. Motor: Motor is permanent split capacitor type, direct drive, 3 speed. Motor temperature rise design criteria less than 50°C on all speeds. Optional 115 or 277 voltage.

I. Motor to be an Electrically Commutated Motor (ECM) with a minimum efficiency of 70% throughout the operating range. Motor speed to be controlled for a constant delivery fan cfm regardless of varying external static pressure. Provide remote adjustment option for integration with DDC controls by others.

J. Fan Controls: Factory mounted on-off toggle switch, for disconnect and normally open P.O. switch to energize fan.
AIR DISTRIBUTION

K. Disconnect Switch: Provide factory mounted fused disconnect switch with interlocking door handle on terminal box door.

L. Dust Cover: Integral control panel shall be gasketed for tight seal. Hot Water Coil: Where scheduled on drawings, provide a single or double row hot water heating coil with aluminum fins mechanically bonded to copper coils. Coil velocity shall not exceed 700 FPM and static pressure loss shall not exceed .35" W.G. for a double row coil or 0.20 for a single row coil. Coil shall be pressure tested to 200 PSIG.

M. Electric Coil: Terminal manufacturer to factory install coil. Coil to be UL listed. They shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 5" to prevent damage to elements during shipping. Elements shall be derated nickel chrome, supported by ceramic isolators a maximum of 3.5" apart, staggered for maximum thermal transfer and element life and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety device. Provide a primary automatic reset thermal cutout, a manual reset secondary thermal cutout, line fusing, mercury contactors per element, differential pressure airflow switch for proof of flow, and line terminal block. Unit shall include an integral door interlock type disconnect switch which will not allow the access door to be opened while power is on. Coils 4kw to 8kw shall be 2 stage, 8kw and larger shall be 3-stage. Coordinate final voltages with Div. 26.

N. VAV Control: Factory mounted and piped to pneumatic or electronic actuator. Regulator is thermostatically reset with velocity controller, which provides constant delivery air control within ±10% accuracy regardless of inlet condition. The velocity signal is input to the volume regulator, which will automatically adjust valve position to compensate for either increase or decrease in duct pressure. Adjustable set points provided to set maximum and minimum cfm. Reverse acting control sequence must be used. Bleed rate 25 scrim. Integral flow ring taps and calibration chart shall be provided on unit.

O. Manufacturer: Trane VFWC, Titus, Price FDV, FDVLP, FDC, FDCLP, Carnes, Enviro-Tec, Nailor 35P (parallel boxes), 35SST (Series) or approved equal by Krueger or Anemostat.

2.23 ELEVATOR SHAFT VENTS

A. Furnish and install elevator shaft vents at top of each elevator shaft over 25’ high as required by code.

B. Vents to be sized with throat area equal to 3.5% of elevator shaft hoist way area with minimum size of 3 sq. ft.

C. Vents to be Greenheck model “GRS” with bird screen and prefab curb or Loren Cook Company or the equivalent. Minimum size to meet 3 square feet requirement is size GRS-24 (3.24SF Throat will handle 92SF shaft). Upsize as required.

D. Locate to miss beams and coordinate size and location of roof opening with structural.

PART 3 - EXECUTION

3.1 DUCTWORK MATERIAL APPLICATION SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Underground Ducts:
      a. For ductwork 24” diameter or smaller: Concrete-encased: [galvanized sheet steel] [PVC-coated, galvanized sheet steel with thicker coating on duct exterior] [stainless steel].
      b. Fiberglass reinforced plastic (FRP)
   2. Non-toxic and non-hazardous wet vapor exhaust, such as dishwasher, and shower exhaust systems:
      a. Material: Type 316L stainless steel, minimum 24 gage spiral or sheet metal ductwork. Type 316 stainless steel fittings.
AIR DISTRIBUTION

b. Joints: welded, or swaged lap-joint with silicon caulk and stainless steel sheet metal screws.
c. All accessories shall be stainless steel including dampers, damper hardware and turning vanes.

3. Type II Kitchen hoods and dishwasher exhaust hoods or connections: 20 gauge stainless steel ductwork with longitudinal seam at top of horizontal runs and all joints sealed watertight. Slope duct back to point of air inlet. Ductwork may be constructed of aluminum and of other gauges with pre-approval, and as allowed by SMACNA guidelines and local jurisdiction.

4. All duct system appurtenances are to be the same material as ductwork including volume dampers and access panels.

5. Kitchen Grease Exhaust Ductwork:
   a. Grease exhaust ducts for Type I hoods shall be constructed of 16 gauge steel or 0.044" stainless steel with liquid tight welded or brazed joints in accordance with the mechanical code. Provide bolted access doors at each elbow and at the base of each riser sized to allow proper cleaning. Use long or short radius elbows. Do not use turning vanes or square elbows. All joints in vertical riser to be water tight to prevent leakage of condensation. Ducts exposed to outside atmosphere to be protected against corrosion as required by code. Ducts to be galvanized, painted with non-corrosive paint or insulated.
   b. As an alternate method to enclosing the duct in a rated shaft enclosure - furnish and install on the exhaust duct, a 2 hour fire rated board or blanket wrap. See Section 230700 HVAC Insulation for specification.

3.2 DUCTWORK AND SPECIALTIES INSTALLATION

A. Ductwork is generally diagrammatically indicated and shall be generally installed as indicated. Do not scale Drawings for exact location of ducts. Install ducts to best suit field conditions and cooperate with other trades. Do not penetrate Structural members without consent of Architect or Structural Engineer. Check with Structural drawings prior to locating any penetrations. Duct sizes are indicated as net inside dimensions on the Drawings. The indicated dimensions shall be altered at the job site for the purpose of avoiding interferences and clearance difficulties to other dimensions producing the same air handling characteristics, provided such altered dimensions are approved by the Architect. Ducts shall be constructed in accordance with the latest edition of codes and standards identified in Part 1 and as shown on the Drawings.

1. Clean and pretreat surfaces before application of sealant. Conform to the manufacturer's cleaning procedures. Install sealants in conformance with manufacturer's instructions.

2. Except where noted, vertical ducts or horizontal ductwork penetrating fire rated ceilings, roofs, walls and floors shall be fire separated with UL listed and labeled fire dampers installed per UL tested assembly including sleeves and retaining angles. Provide additional fire dampers indicated on the Drawings and as otherwise required by the IBC and building inspector. Provide approved firestopping between damper frames and firewalls. Install fire dampers in accordance with NFPA Standards, requirements of the State Fire Marshal, and applicable codes. Ensure that fire dampers are installed in the open position.

3. For penetration of fire rated partitions which meet the IBC Chapter Seven requirements of non-Group H occupancy penetration of tenant separation and corridor walls in buildings with fire sprinklers provide metal sleeves as follows: A minimum 12 inch-long (0.30 m) by 0.060 inch thick (1.52 mm) steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 1 1/2" inch by 1 1/2 inch by 0.060 inch steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 screws. The annular space between the steel sleeve and wall opening shall be filled with rock wool batting on all sides

4. Grilles, Registers and Diffusers: Install flush, squared, tightly sealed, and entirely covering sheet metal ductwork and gaskets. Thread sheet metal mounting screws tightly into sheet metal. All frames shall be selected to fit the ceiling type. Verify with
AIR DISTRIBUTION

Architectural Drawing. Each diffuser, grille and register shall be individually capable of balancing via duct mounted balancing dampers or attached opposed blade dampers. Provide unit opposed blade damper only where individual duct mounted balancing dampers are specifically noted as not provided. Duct connections shall fit securely to necks or collars behind face area. Provide all necessary transition pieces and duct collars to make connections from ductwork to neck sizes. Where ducts connect directly to necks or collars provide a minimum straight duct section of two times the duct diameter to the last elbow. Where minimum straight duct sections are not physically possible provide sheet metal plenum sized for approximately 500 fpm air velocity with duct tapped directly to side of plenum. Where building walls, floors and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted and sealed to building structure.

5. Install turning vanes in all mitered elbows in all ducts, so that tips are parallel with the sides of the ducts. Vanes shall be single thickness type. Tips of acoustical turning vanes on outside radius shall be flush with acoustical lining.

6. Provide flexible connections to completely isolate fans from direct contact with all sheet metal work.

7. Provide access panels or doors, as required, for access to valves, controllers, fire dampers and humidifier dispersion tubes. Access doors required in Product Conveying Vapor/Moisture Ductwork (see applicable paragraph above) shall not be installed in the bottom of the duct or in a manner to allow leaks.

8. Volume Dampers: Provide manual volume dampers in all low pressure supply, return and exhaust branch ductwork to grilles, diffusers, inlet and outlet openings to facilitate balancing of systems. These are to be provided as part of contract whether shown on plans or not. Where ceilings are not accessible, provide access door or remote damper operator.

9. Splitters and splitter dampers shall not be installed in medium or low pressure supply ductwork to VAV systems.

B. Hangers and Supports: Securely fasten all ductwork to the building construction by means of hangers, supports, guides, anchors, and sway braces to maintain duct alignment, to prevent sagging, and to prevent noise and excessive strain on ductwork due to movement under operating conditions.

1. Maximum spacing between hangers shall not exceed eight (8) feet.

2. Adequately mount and anchor all material and equipment as required. Include lateral bracing as required to prevent horizontal, seismic movement. Refer to IBC and architectural Drawings for seismic requirements.

3. Do not support ductwork from fans or any other pieces of equipment.

4. Powder driver fasteners shall not be used to support rectangular ducts of 40” maximum dimension. Powder driven fasteners shall not be allowed in existing facilities where electronic equipment is located.

5. Support round duct, 30” and larger, with two hangers at each support point.

6. Hangers and supports shall conform to SMACNA section "Hangers and Supports". Nail inserts, hangers and supports to formwork before slabs are poured. Cut off or remove nails, strap-ends and other projections, flush with concrete after forms are removed.

7. Support vertical ducts, passing through floors with two continuous angles screwed to the duct and bearing to the floor and conforming to SMACNA section "Riser Support-From Floor". Blocking or shimming ducts will not be permitted.

C. Other:

1. Fans: Align fans, motors, and drives. Install fans to render bearings accessible for lubrication without dismantling fans or ducts. Provide extended bearing oilers as required. Mount all fans on vibration isolators as specified.

2. Insulation: Properly and neatly apply insulation on all material and equipment and apparatus, as specified, including all fittings. Apply insulation over clean, dry surfaces, with adjoining sections firmly butted together and canvas smoothly pasted over. When
vapor barriers are specified, install continuous overall external surfaces of the entire system.

3. Duct Sizing: Where duct sizes are not specifically shown on the plans or must be modified due to physical limitations, supply ducts may be sized at a maximum velocity of 1,500 fpm or 0.08" sp friction per 100 feet, whichever provides the larger duct, and return/exhaust/intake ducts may be sized at a maximum velocity of 1,000 fpm or 0.06" sp friction per 100 feet, whichever provides the larger duct.

4. Humidifiers: Humidifier installation shall be approved by manufacturer and coordinated with all other systems. Condensate piping shall include p-traps as recommended by the humidifier manufacturer. Insulate exposed piping as required by the code.

5. Access Floor Diffusers: The mounting ring for floor mounted diffusers are to be affixed to the floor tiles using a clamp insert or other method approved for use with the floor diffuser.

3.3 STAINLESS STEEL DUCTWORK

A. For installations serving moisture, vapor, or fume exhaust.

1. For connections to hoods or equipment provide minimum 12" length flanged and bolted stainless steel spool piece connection.

2. All fittings shall be long radius. Round elbows shall be minimum 5 gore.

3. Slope horizontal ductwork back toward source connected equipment minimum 1% slope so that moisture and liquids may drain back toward equipment.

4. Low point "traps" in the ductwork shall be fitted with a low point drain valve, ½" welded connection, stainless steel piping and valve.

5. All welding to be completed by certified welders experienced in 316 grade stainless.

3.4 CONSTRUCTION AND SEALING CRITERIA

A. Unless called out otherwise on drawings the pressure classification of ductwork shall be as follows:

<table>
<thead>
<tr>
<th>Duct system:</th>
<th>Location</th>
<th>Working Pressure</th>
<th>Build to SMACNA Pressure Class</th>
<th>Build to SMACNA Seal Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor air intake</td>
<td>From ambient intake to AHU</td>
<td>-1&quot; wc</td>
<td>-2&quot; wc</td>
<td>B</td>
</tr>
<tr>
<td>Med press Supply Air</td>
<td>From AHU to air terminal units</td>
<td>+6&quot; wc</td>
<td>+10&quot; wc</td>
<td>A</td>
</tr>
<tr>
<td>Med press Supply Air</td>
<td>From AHU to air terminal units</td>
<td>+4&quot; wc</td>
<td>+6&quot; wc</td>
<td>A</td>
</tr>
<tr>
<td>Med press Supply Air</td>
<td>From AHU to air terminal units</td>
<td>+2&quot; wc</td>
<td>+3&quot; wc</td>
<td>A</td>
</tr>
<tr>
<td>Low press Supply Air</td>
<td>Downstream of air terminal units to grilles, registers or diffusers.</td>
<td>Low pressure</td>
<td>+1&quot; wc</td>
<td>B</td>
</tr>
<tr>
<td>Low press Supply Air</td>
<td>From AHU to grilles, registers or diffusers.</td>
<td>Low pressure</td>
<td>+1&quot; wc</td>
<td>B</td>
</tr>
<tr>
<td>Med. Press Return air</td>
<td>From air terminal units to AHU</td>
<td>-3&quot; wc</td>
<td>-4&quot; wc</td>
<td>A</td>
</tr>
<tr>
<td>Med. Press Return air</td>
<td>From air terminal units to AHU</td>
<td>-2&quot; wc</td>
<td>-3&quot; wc</td>
<td>B</td>
</tr>
<tr>
<td>Med. Press Return air</td>
<td>From air terminal units to AHU</td>
<td>-1&quot; wc</td>
<td>-2&quot; wc</td>
<td>B</td>
</tr>
</tbody>
</table>
### AIR DISTRIBUTION

<table>
<thead>
<tr>
<th>Duct system:</th>
<th>Location</th>
<th>Working Pressure</th>
<th>Build to SMACNA Pressure Class</th>
<th>Build to SMACNA Seal Class:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low press Return air</td>
<td>From return grilles to AHU</td>
<td>Low pressure</td>
<td>-1” wc</td>
<td>B</td>
</tr>
<tr>
<td>Transfer air</td>
<td>From grille to grille, or acoustic boots or “z” bends</td>
<td>Low pressure</td>
<td>+0.5” wc</td>
<td>C</td>
</tr>
<tr>
<td>Relief air</td>
<td>From AHU to discharge at ambient</td>
<td>+1” wc</td>
<td>+2” wc</td>
<td>B</td>
</tr>
<tr>
<td>General exhaust</td>
<td>From grille to exhaust fan</td>
<td>-1” wc</td>
<td>-2” wc</td>
<td>B</td>
</tr>
<tr>
<td>General exhaust</td>
<td>From exhaust fan to discharge at ambient</td>
<td>+1” wc</td>
<td>+2” wc</td>
<td>B</td>
</tr>
<tr>
<td>Washroom exhaust</td>
<td>From grille to exhaust fan</td>
<td>-1” wc</td>
<td>-2” wc</td>
<td>B</td>
</tr>
<tr>
<td>Washroom exhaust</td>
<td>From exhaust fan to discharge at ambient</td>
<td>+1” wc</td>
<td>+2” wc</td>
<td>B</td>
</tr>
<tr>
<td>Type II Kitchen Hood vapor/ low temp, and dishwasher exhaust</td>
<td>From Hood or equipment to exhaust fan</td>
<td>-2” wc</td>
<td>-3” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
<tr>
<td>Type I Kitchen Hood medium/high heat, grease exhaust</td>
<td>From Hood to exhaust fan</td>
<td>-3” wc</td>
<td>-4” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
<tr>
<td>Dust collection exhaust</td>
<td>From floor machine tool to dust collector</td>
<td>-4” wc</td>
<td>-6” wc</td>
<td>A, or welded. Refer to specification</td>
</tr>
</tbody>
</table>

B. The default leakage classification of ductwork is as follows:

<table>
<thead>
<tr>
<th>Duct working press. class:</th>
<th>Low pressure less than +/-0.5”wc</th>
<th>+/-0.5” to +/-2.99”</th>
<th>+/-3” to +/-10” wc</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMACNA Seal Class</td>
<td>C</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Sealing Applicable</td>
<td>Transverse joints only</td>
<td>Transverse and longitudinal Joints</td>
<td>Joints, seams, and all wall penetrations</td>
</tr>
<tr>
<td>Rectangular sheet metal SMACNA Leakage Class</td>
<td>24</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Round sheet metal SMACNA Leakage Class</td>
<td>12</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

### 3.5 MANDATORY DUCTWORK TESTING

### 3.6 FIBERGLASS DUCTWORK INSTALLATION
AIR DISTRIBUTION

A. Ductwork fabrication and installation to be inspected by a Qualified Fabricator certified by the material manufacturer.

3.7 COMBINATION FIRE, SMOKE DAMPER INSTALLATION

A. Install per manufacturer’s and UL installation requirements.
B. Interlock operation of all fire smoke dampers to close dampers when the fans associated with the dampers are shut down. This also includes dampers in transfer ducts associated with system fans.
C. For buildings with no fire alarm system all fire smoke dampers shall be interconnected with the HVAC units controls and duct smoke detectors. The detection of smoke at any fire smoke damper shall stop for HVAC unit fans and close all fire smoke dampers. A single test/reset station shall be capable or resetting all devices back to normal operation.

3.8 CONTROL DAMPER INSTALLATION

A. Note that installation of control dampers is a part of the mechanical contractor’s work regardless of whether they are specified in this section or as part of products to be selected by the Control Contractor.
B. When electric actuators are provided, dampers shall be installed to allow direct over the shaft mounting of actuators. No connecting rods and stand off brackets shall be necessary.
C. Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error.
D. Blades shall close completely. Leakage shall not exceed manufacturer’s specifications at rated static.
E. Structural support shall be provided as necessary for all multi-section dampers.
F. Where blankoffs or structural supports obstruct duct or air passages, the decrease in free area shall not exceed 15% of the damper face area unless otherwise specified here or on plans.
G. No individual damper section may exceed 20 sq. ft.
H. Dampers shall be parallel blades style for outside air economizer to facilitate improved mixing of outside air and return air. Airflows shall be directed towards each other.

3.9 SEISMIC REQUIREMENTS

A. See Section 230548 for specific requirements.
B. All HVAC equipment and machinery shall be anchored to withstand forces generated by earthquake motions. As a minimum, equipment and equipment frames shall be designed to withstand a force of 100% of the weight of the equipment and frame acting at its center of gravity. Anchorage of the equipment and/or frame to the structure shall be for a force of four times gravity also acting at the center of gravity.
C. The seismic calculations shall be the responsibility of contractor.

3.10 EQUIPMENT

A. Install equipment as shown on plans and in accordance with manufacturer's installation recommendations.

3.11 SUPPLY DIFFUSER AND REGISTER LOCATIONS

A. Coordinate location of supply outlets with ceiling mounted smoke detectors. Locate outlets or outlet distribution so as to prevent airflow from inhibiting the operation of smoke detectors. Locate ceiling outlets a minimum of 3'-0" from smoke detectors.

3.12 PAINTING
AIR DISTRIBUTION

A. Where the interior surfaces of ductwork are visible through the blades of supply outlets, return inlets, and exhaust inlets - paint the interior visible surfaces with one coat of flat black paint.

3.13 FIELD QUALITY CONTROL

A. Do not insulate or conceal ductwork before inspection by Owner's Representative, Architect or Engineer. If ductwork is insulated and concealed prior this inspection the Contractor shall remove insulation and ceiling to permit inspection at no additional cost to the Owner. The Contractor shall replace the insulation and ceiling after final inspection at no additional cost to the Owner.

B. Ductwork Deflection Criteria:
   1. Maximum inward and/or outward deflection at sheet metal panels shall be 3/4" under maximum static pressure operating conditions. Additional intermediate stiffening angles shall be installed where deflections exceed 3/4".
   2. Maximum inward and/or outward deflection at sheet metal elbows and joints shall be 1/4" under maximum static pressure operating conditions. Additional stiffening angles shall be installed where deflections exceed 1/4".

C. Acceptance of duct systems shall be contingent upon conformance with the requirements specified in Section 230593 "Testing, Adjusting and Balancing".

3.14 ADJUSTING AND CLEANING

A. Clean the inside of plenums, casings, enclosures, fans, and accessible ductwork before starting fans. Blowout coils and condensate piping with compressed air. Install a clean set of filters in each system prior to testing and balancing. Proceed with testing and balancing. All dampers shall be locked in place.

END OF SECTION
FANS AND VENTS

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:

1. Spun Aluminum and Steel Housed Centrifugal Exhaust Fans
   a. General Duty Spun Aluminum Exhaust fan
   b. Upblast Spun Aluminum Exhaust Fan for roof or sidewall mount
   c. Upblast Spun Steel Exhaust Fan for high temperature kitchen exhaust

2. Small Cabinet Fans (Ceiling Mounted and Inline)

3. Housed Centrifugal Fans
   a. direct drive
   b. belt drive
   c. Industrial duty high temperature exhaust fan

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Section 233113: Air Distribution
F. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."

C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:

1. Air Movement and Control Association (AMCA):
   a. 99 standards Handbook
   b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
   c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
   d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
   e. 500 Test Method for Louvers, Dampers, and Shutters

   a. 9 Load Ratings and Fatigue Life for Ball Bearings
   b. 11 Load Ratings and Fatigue Life for Roller Bearings
   c. 900 Test Performance of Air Filter Units

3. Air-Conditioning and Refrigeration Institute (ARI):
   a. 350 Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
   b. 410 Forced-Circulation Air-Cooling and Air-Heating Coils

SERA Architects Inc.  Package 4 - 50% Construction Documents
FANS AND VENTS

c. 430 Central-Station Air-Handling Units
d. 440 Room Fan-Coil Air-Conditioners

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 Safety Code for Mechanical Refrigeration

5. National Electrical Manufacturers Association (NEMA): Except for motors, provide
   electrical components required as part of air handling units, which comply with NEMA
   Standards.

6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation
   having flame spread rating not higher than 25 and smoke developed rating not higher
   than 50:
   a. 70 National electrical Code
   b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):
   Comply with applicable SMACNA standards including "HVAC Duct Construction
   Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components
   required as part of air handling units, which have been listed and labeled by UL.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air handling units showing
   dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated,
   motor electrical characteristics, and finishes of materials, installation instructions, sound and
   vibration test report, and bearing life calculations.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required
   clearances, field connection details and methods of support. Draw to a scale of 1/4” per one foot.
   Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter
   replacement, motor and drive replacement, and spare parts lists. Include this data, product data,
   shop drawings, and wiring diagrams in operating and maintenance manuals.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage.
   Do not install damaged unit - remove from project site.

1.8 WARRANTY

A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and
   living expenses incurred by the manufacturer to provide factory authorized service.

1.9 SAFETY PROVISIONS

A. Provide all open drives and fan wheels subject to maintenance and potential entanglement with
   protective guards or screens meeting OSHA requirements.

PART 2 - PRODUCTS

2.1 GENERAL FAN REQUIREMENTS
FANS AND VENTS

A. Construction, Rating and Testing: Provide fans constructed and factory tested in accordance with the Air Moving and Conditioning Association (AMCA). All fan wheels shall be statically and dynamically balanced. Size and capacity as indicated on the Drawings. Provide extended bearing lubrication fittings where necessary to assure accessibility of all lubrication points.

B. Motors and Drives: Provide premium efficiency drip-proof motors with temperature rise not greater than 40 degrees C above ambient temperature. Provide belt drive assembly capable of 150% of the motor rated horsepower on one less than the total number of belts, for belt drives with two or more belts. All drives shall have adjustable sheaves to allow adjustment of ±20%. Provide two speed, two winding motors where indicated on schedules.

C. Accessories: Provide, as indicated on the Drawings and specified in other paragraphs of this Section, all related accessories to match the fan section, including access sections, diffusion sections, transition sections, flexible connections, vibration eliminators, and belt guards.

D. Submissions: For shop drawings include complete dimensional and physical data, CFM, SP, HP, discharge arrangement, rotation, class, base details, and fan curves.

2.2 SPUN ALUMINUM AND STEEL HOUSED CENTRIFUGAL EXHAUST FANS

A. Manufacturer: Models as scheduled manufactured by Greenheck, Carnes, Cook, Penn, Twin City or approved equal.

B. General Duty Spun Aluminum Exhaust Fan

1. Direct Drive: Spun aluminum exhaust fans shall be direct drive type.
   a. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure and a birdscreen.
   b. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors shall be readily accessible for maintenance. A disconnect switch shall be factory installed and wired from the fan motor to a junction box within the motor compartment.
      1) Variable speed capability: For all direct drive fans with motors through ¾" hp, the fan shall be equipped with a DC electronic commutation type motor (ECM). Motor shall be speed controllable to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by a 0-10 vdc signal. Motor shall be 85% efficient at all speeds.
   c. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
   d. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.

2. Belt-drive: Spun aluminum exhaust fans shall be belt driven type.
   a. Fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure and a birdscreen.
   b. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors and drives shall be readily accessible for maintenance.
FANS AND VENTS

c. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life of 500,000 hours) at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.

d. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.

e. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.

f. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.

C. Upblast Spun Aluminum Exhaust Fan for Roof or Sidewall Mount

1. Direct Drive:
   a. Spun aluminum exhaust fans shall be upblast centrifugal direct drive type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure.
   
   b. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment free of discharge contaminants. Motors shall be readily accessible for maintenance. A disconnect switch shall be factory installed and wired from the fan motor to a junction box within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.

   1) Variable speed capability: For all direct drive fans with motors through ¾" hp, the fan shall be equipped with a DC electronic commutation type motor (ECM). Motor shall be speed controllable to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor or by a 0-10 vdc signal. Motor shall be 85% efficient at all speeds.

c. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.

d. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.

e. Fan Arrangement:

   1) Roof Mounted Upblast Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength.

   2) Sidewall Mounted Exhaust Fans: A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength. Fan shall be provided with a mounting plate, which is attached and sealed to the wall prior to locating the entire unit.

2. Belt-drive: Spun aluminum exhaust fans shall be belt driven type.
   a. Fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The windband shall be welded to the one-piece curb cap and on all sizes with UL/CUL-762.
FANS AND VENTS

b. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a tube sized for sufficient fresh air to provide motor cooling. Motors and drives shall be readily accessible for maintenance.

c. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life of 500,000 hours) at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. Third pulley to be included for ease of adjusting drive belt tension and to enhance belt life.

d. A NEMA 3R disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.

e. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.

f. Each fan shall bear a permanently affixed manufacturer’s engraved metal nameplate containing the model number and individual serial number for future identification.

g. Fan Arrangement:
   1) Roof Mounted Upblast Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength.
   2) Sidewall Mounted Exhaust Fans A leakproof fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength. Fan shall be provided with a mounting plate, which is attached and sealed to the wall prior to locating the entire unit.

h. Options:
   1) Fans shall be Listed by Underwriters Laboratory for UL/cUL 762 Listed for all electrical components and grease removal
   2) Grease Provisions:
      a) Drain connection shall be constructed of aluminum and allow for a single point drainage of grease, water or other residues.
      b) Grease Trap shall include the drain connection and shall be constructed from aluminum. The unit shall collect grease and water from the fan and extract the grease from the water for ease of grease disposal
   3) Easy Clean Options: Provide a curb hinge kit constructed of heavy gauge hinges and including hold open cables or chain for field installation. Non Stick wheel shall be constructed of aluminum with a non stick coating simular to Teflon® as manufactured by Dupont. Clean out port shall have a hole on the outside of the windband and a grease repellent compression rubber fit, allowing access to entire wheel for cleaning.
   4) Vented Curb Extensions: Shall be mounted between roof curb and roof mounted fans to meet NFPA requirements of 40 in. minimum discharge above the roof when mounted on a minimum 8 in. high roof curb.
   5) Windband Extension shall be constructed from heavy gauge aluminum tube that raises the discharge an additional 36 inchesSmoke Exhaust Option:
      a) Provide dual belt drives be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.
FANS AND VENTS
b) Fans shall be listed by Underwriters Laboratory for UL/cUL 705 for electrical components and UL/cUL Listed for Emergency Smoke Control Systems (500˚ F (260˚ C) for 4 hours and 1,000˚ F (538˚ C) for 15 minutes).

D. Upblast Steel Exhaust Fan for High Temperature Kitchen Exhaust
   1. General: Provide for charbroil and solid fuel burning exhaust applications
   2. Spun steel exhaust fans shall be centrifugal belt driven type. Fan wheel shall be centrifugal backward inclined type. The wheel shall be constructed of steel and coated with a non stick coating simular to Teflon® as manufactured by Dupont. Wheel shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
   3. The fan housing shall be constructed of 16 gauge galvanized steel with a rigid internal support structure and shall be leakproof. The fan housing shall be constructed with a one piece windband with an integral rolled bead for added strength and shall be joined to the curbcap with a continuously welded seam.
   4. Fan's windband shall have a Clean Out Port, a large diameter hole on the outside of the fan's windband with a grease repellent compression rubber fit, allowing access to entire wheel for cleaning.
   5. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge galvanized steel. Motors and drives shall be mounted on heavy duty true vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment through a ten square inch tube free of discharge contaminants. Motors and drives shall be readily accessible for maintenance. Precision ground and polished 1 inch minimum diameter fan shafts shall be mounted in cast pillow block lubricatable ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 life of 500,000 hours) at maximum cataloged operating speed. Dual drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the cast type, keyed and securely attached to the wheel and motor shafts.
   6. Motor pulleys shall be adjustable for final system balancing. All fans shall have a dual belt and pulley system.
   7. A NEMA-3R disconnect switch shall be factory installed and wired from the fan motor to a junction box installed outside the motor compartment.
   8. Certification and Identification:
      a. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
      b. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
      c. Fans shall be Listed by Underwriters Laboratory for UL/cUL 762 Listed for all electrical components and grease removal. Grease Trap shall include the drain connection. The unit shall collect grease and water from the fan and extract the grease from the water for ease of grease disposal.
   9. Hinge kit shall be constructed of heavy gauge hinges and shall include hold open cables for field installation.

2.3 SMALL CABINET FANS (CEILING MOUNTED AND INLINE CABINET)
A. Ceiling mounted exhaust fans:
   1. Manufacturer: Greenheck SP-A, Panasonic, Cook, Penn, Carnes, Twin City or manufacturer of equivalent performance.
   2. General: Provide centrifugal direct drive type ceiling exhaust fan. The fan wheel(s) shall be of the forward curved centrifugal type and dynamically balanced.
   3. Noise Data: Provide sone or octave band noise values at the required air delivery.
   4. Fan Housing: The fan housing shall be constructed of heavy gauge galvanized steel. The housing interior shall be lined with 1/2 inch acoustical insulation. The outlet duct collar
FANS AND VENTS

shall include an aluminum backdraft damper on all sizes and shall be spring loaded on larger units above 200 cfm.

a. Integral backdraft damper shall be totally chatterproof with no metal-to-metal contact.
b. Entire fan, motor and wheel assembly shall be easily removable without disturbing the housing.
c. Outlet shall be adaptable for horizontal or vertical discharge.

5. Motor speeds shall not exceed 1100 RPM and all fan motors shall be suitably grounded and mounted on rubber-in-shear vibration isolators.

6. Grille: For 300 cfm and smaller fans the grille shall be constructed of high impact polystyrene and for larger sizes the grille shall be constructed of aluminum. Grilles shall be non-yellowing.

7. The access for wiring shall be external. The motor disconnect shall be internal and of the plug in type. The motor shall be mounted on vibration isolators.

8. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be UL/cUL Listed.

B. Duct mounted cabinet fan

1. Manufacturer: Greenheck CSP-A, Panasonic, Cook, Penn, Carnes, Twin City of manufacturer of equivalent performance.

2. General: Provide centrifugal direct drive type inline fan. The fan wheel(s) shall be of the forward curved centrifugal type and dynamically balanced.

3. Noise Data: Provide sone or octave band noise values at the required air delivery.

4. Fan Housing: The fan housing shall be constructed of heavy gauge galvanized steel. The housing interior shall be lined with 1/2 inch acoustical insulation. The outlet duct collar shall include an aluminum backdraft damper on all sizes and shall be spring loaded on larger units above 200 cfm.

a. Integral backdraft damper shall be totally chatterproof with no metal-to-metal contact.
b. Entire fan, motor and wheel assembly shall be easily removable without disturbing the housing.
c. Outlet shall be adaptable for horizontal or vertical discharge.

5. Motor speeds shall not exceed 1100 RPM and all fan motors shall be suitably grounded and mounted on rubber-in-shear vibration isolators.

6. Grille: For 300 cfm and smaller fans the grille shall be constructed of high impact polystyrene and for larger sizes the grille shall be constructed of aluminum. Grilles shall be non-yellowing.

7. The access for wiring shall be external. The motor disconnect shall be internal and of the plug in type. The motor shall be mounted on vibration isolators.

8. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be UL/cUL Listed.

2.4 HOUSED CENTRIFUGAL FANS

A. Utility Set

1. Manufacturer: Trane, Loren Cook, Carnes, Industrial Air, Peerless-Winsmith, Aerovent, Twin City, or approved equal.

2. Direct Drive Utility Fans:

a. Supply, exhaust or return air fans shall be of the direct drive utility fan type, in AMCA Arrangement 4 with a single width, single inlet housing, in CW or CCW rotation as specified. The housing shall be constructed of heavy gauge galvanized steel with lock formed seams permitting no air leakage. The housing shall be easily rotated in the field to any of the eight standard discharge positions. Housing supports shall be constructed of heavy gauge galvanized steel to minimize vibration and rigidly support the motor and wheel.

b. The fan wheel shall be of the forward curved or backward inclined type and shall be constructed of heavy gauge aluminum. Wheels shall be statically and dynamically
FANS AND VENTS

balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency. Motors shall be heavy duty ball bearing type matched to the fan load and furnished at the specified voltage, phase and enclosure.

3. Belt Drive Utility Fans:
   a. Supply, exhaust and return air fans shall be of the belt driven utility fan type in AMCA Arrangement 10 with a single width, single inlet housing, in CW or CCW rotation as specified. The housing shall be constructed of heavy gauge steel with air tightlock formed seams. The housing shall be easily rotated in the field to any of the eight standard discharge positions. Housing and bearing supports shall be constructed of welded steel members to prevent vibration and to rigidly support the shaft and bearings.
   b. Fan wheels shall be of the forward curved type, constructed of heavy gauge steel with uniform stamped steel blades. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched for maximum performance and operating efficiency.
   c. Motors shall be heavy duty, ball bearing type, matched to the fan load and furnished at the specified voltage, phase and enclosure. The fan shaft shall be ground and polished solid steel mounted in heavy duty, permanently sealed, pillow block ball bearings. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours of maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulley shall be adjustable for final system balancing.

4. All fans shall bear the AMCA Certified Ratings Seal for air performance.

B. Industrial Duty High Temperature Exhaust Fan
   1. Process or material handling fans shall be of the heavy duty type with inlet diameters and outlet areas manufactured in accordance with standards adopted by AMCA for industrial fans.
   2. Housing: Fan housings shall be of continuously welded plate to assure no air leakage. The housing and bearing support shall be constructed of welded structural steel members to support the shaft and bearings.
   3. The fan wheel shall be fully welded and of either the open material handling, backplate material handling or air handling type. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
   4. Turned, precision ground and polished steel shafts shall be sized so the first critical speed is at least 25% over the maximum operating speed for each construction class. Close tolerances shall be maintained where the shaft passes through the bearing.
   5. Bearings shall be heavy duty grease lubricated, ball or roller pillow block type. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed and horsepower for each construction level.
   6. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in the horizontal, vertical, and axial direction. The maximum allowable fan vibration shall be 0.15 in/sec peak velocity, filter in measured at the fan RPM.
   7. Fans shall be licensed to bear the AMCA Seal for sound and air performance.
   8. Industrial process fans shall be designed for air handling as manufactured by Greenheck, Cook, Carnes, Twin City or equal and shall be supplied as shown on the plans and in the fan schedule.

PART 3 - EXECUTION EDIT AS APPLICABLE

3.1 INSTALLATION
   A. Coordinate motor starters with Div. 26 and control contractor.
FANS AND VENTS

B. Install in accordance with manufacturer's instructions.

C. Examine site to verify if site is ready to receive work. Provide layout drawings of air handlers and fan locations to electrical installer.

D. Install unit on vibration isolators.

E. Install 3" flexible duct connection at inlets and outlets of units.

F. Control installers shall install all wiring associated with control signals into the fan starters.

G. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

3.2 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION
KITCHEN EXHAUST AND POLLUTION CONTROL

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
   1. Kitchen Hoods
   2. Kitchen Exhaust Pollution Control (Scrubbers)

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Section 233413: Fans and Vents
F. Section 233113: Air Distribution
G. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."

C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 standards Handbook
      b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
      c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
      d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
      e. 500 Test Method for Louvers, Dampers, and Shutters
      a. 9 Load Ratings and Fatigue Life for Ball Bearings
      b. 11 Load Ratings and Fatigue Life for Roller Bearings
      c. 900 Test Performance of Air Filter Units
   3. Air-Conditioning and Refrigeration Institute (ARI):
      a. 350 Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
      b. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
      c. 430 Central-Station Air-Handling Units
      d. 440 Room Fan-Coil Air-Conditioners
   4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. 15 Safety Code for Mechanical Refrigeration
KITCHEN EXHAUST AND POLLUTION CONTROL

5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.

6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 National electrical Code
   b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of 1/4" per one foot. Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect equipment and products against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.8 WARRANTY

A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

1.9 SAFETY PROVISIONS

A. Provide all open drives and fan wheels subject to maintenance and potential entanglement with protective guards or screens meeting OSHA requirements.

PART 2 - PRODUCTS

2.1 KITCHEN HOOD (COMPENSATING TYPE)

A. Hood construction: 16 or 14 gauge 304 stainless steel with #3 polish.

B. Hood(s) shall be double wall type capable of providing untempered make-up air into the internal hood capture area through adjustable rotatable supply air nozzles. Nozzles shall be capable of being locked in position after balancing.
KITCHEN EXHAUST AND POLLUTION CONTROL

C. Untempered air being introduced into the hood shall first encounter a perforated stainless plate to spread the air across the full length of the air plenum before entering the adjustable rotatable stainless outlet nozzles.

D. The hood supply air plenum shall be completely lined with 1 inch thick 3# density U.L. Listed foil faced rigid insulations having a flame spread of 25 or below. Joints in insulation shall be sealed with aluminum thermal tape. Bottom of the supply plenum shall be lined with galvanized steel to facilitate cleaning.

E. End panels shall be 1 inch thick insulated double wall construction to prevent condensation on end walls. Hanger brackets shall be provided on each corner of hood and threaded to accept ½ inch rod. Additional hangers shall be provided on hoods over 132 inches in length.

F. All exterior seams shall be continuously welded, liquid tight as required by U.L., and ground and polished to match the original finish of the material. Hood(s) shall be fabricated in accordance with National Fire Protection Association (NFPA) Bulletin No. 96, shall be National Sanitation Foundation (NSF) listed and bear the NSF seal, and shall be Underwriters Laboratories (U.L.) Listed and U.L. labeled as required. U.L. Listed exhaust air fire dampers shall be provided if required by local code. Hood shall include a U.L. Listed fire damper for each supply collar.

G. The full length filter housing with pitched grease trough shall be of 18 gauge, type 304, #3 polish stainless steel complete with removable stainless steel grease container. Filters shall be U.L. Classified, 2” thick baffle type constructed of aluminum (stainless steel).

H. Lights shall be U.L. Listed incandescent vaporproof 100 watt type on approximately 3 foot centers pre-wired to a junction box on top of the hood. (optional U.L. Listed fluorescent fixtures). Wiring shall conform to the National Electric Code (NEC).

I. Control panels: Remote or mounted flush on face of hood in single or multiple gang box are combinations of light switch, fan switches with pilot light, and control of a possible remote room make-up air system.

J. Manufacturer: Kees or approved equal.

K. Suggested design criteria:
   1. Hood mounting height: Hood front must be from 6'6" to 7'0" above finished floor as required by codes.
   2. Overhang: The inside of the hood supply air plenum should project not less than 6 inches beyond cooking surfaces for wall hoods. Wall hood length should extend not less than 6 inches beyond ends of cooking surfaces. (The use of end skirts can eliminate this need.) 12” overhang on all sides recommended for island hoods.

2.2 TYPE I KITCHEN HOODS

A. General:
   1. Hood construction: 18 or 16 gauge 300 Series stainless steel with #4 polish. Use of 400 Series stainless, Galvanized steel, or aluminized steel is unacceptable.
   2. Hood(s) shall be double wall type on the ends for strength and appearance.
   3. Exhaust flows shall be based on ASTM 1704 testing to determine capture and containment.
   4. The ventilator shall be UL Listed under the category “Exhaust Hood with Exhaust Damper” and listed by NSF. The ventilator shall comply with all requirements of NFPA-96, IMC, UMC, BOCA and SBCCI model codes.
   5. Exhaust flow rate and Pressure drop shall not exceed those of the specified product as shown on the drawings used for the base design.
   6. The hood supply air plenum shall be 12” tall 22” front to back the full length of the hood. Air velocity shall not exceed 150 FPM at the discharge.
   7. A Supercapture lip of a minimum depth of 6” shall be provided at the front edge of the hood.
KITCHEN EXHAUST AND POLLUTION CONTROL

B. Dry Cartridge hood: Each ventilator shall be a high velocity centrifugal grease extractor with an air inlet opening parallel to, and above the cooking equipment being ventilated. Each ventilator shall contain one or more removable “extractor inserts” with a grease extraction efficiency of 90% of the mechanically extractable grease particulate. It shall also include a particulate separator and ultraviolet lamps to remove a majority of the remaining particulate for a total grease extraction efficiency of up to 99% when operated and maintained in accordance with the Technical Manual and design specifications. Extractor inserts shall be constructed of stainless steel and contain full-length, self-draining baffles. Extractors shall be easily removable, for periodic cleaning, from the floor area immediately in front of the equipment by utilizing an extractor removal tool. The grease collecting gutter at the bottom of the extractor housing shall slope to a drain at one end of the ventilator to a removable stainless steel grease cup. The sloped gutter shall be concealed by an apron which extends the full length of the hood. The ventilator shall include a built-in 3” air space at the rear for compliance to NFPA-96 when mounting against a limited combustible wall. Continuous front and rear brackets shall be provided to facilitate mounting to the wall and hanging from the overhead building structure.

1. (Optional) The ventilator shall include “Custom Air” baffles to reduce the exhaust volume over specific cooking equipment as indicated on the plans. The ventilator shall operate at air quantities and static pressure as indicated on plans.

2. Thermostatically Operated Fire Damper (standard) - The damper shall be controlled by an electrically driven actuator, specifically listed for such use and shall be activated by fail safe thermostat(s) located at the duct collar. Upon activation, the exhaust and supply fan shall shut off and the damper shall close, in the direction of air flow, sealing against the front of the plenum and act as a fire barrier to prevent flame from entering the plenum and duct system. The damper shall also close each time the exhaust fan is turned off, to prevent conditioned air from escaping the occupied space via thermal drafts, and then re-open when the exhaust fan is started. Fire dampers located at the exhaust duct collar are not acceptable. The ventilator shall be UL Listed under the category “Exhaust Hood with Exhaust Damper”. Access doors to reach duct fire protection nozzles shall not be permitted.

3. Ultraviolet Light Section: (Optional) The ventilator shall include ultraviolet lamps mounted in modules located in the plenum section. There shall be one or more UV modules, as dictated by the ventilator length, and each module shall be on a slide track for easy removal. There shall also be a particulate separator located in the plenum area immediately upstream of the UV modules. Access to the particulate separator shall be through the ventilator extraction chamber. Access to the modules shall be through keyed hinged doors, and shall include an interlock switch to shut off the lamps in the event the doors are opened during operation. A pressure switch shall be provided to monitor the airflow to prevent operation of the lamps when the airflow is inadequate. The “Extractor Inserts” shall activate an interlock switch to prevent the operation of the UV lamps if an extractor is not in place. Mounted on the plenum of each ventilator section shall be indicating lights to monitor “UV System On”, “Lamp Failure” and “UV Safety Interlock Activated”. A duplicate set of these lights shall be mounted on the ventilator control panel. The control panel shall be equipped with an audible alarm indicating there is a lamp failure or one of the safety interlock switches have been activated. There shall be a hour meter on the control panel displaying the numbers of hours the lights have been operating.

C. Water wash hood CG3 BDL: Each ventilator shall be a high velocity type grease extractor with an air inlet opening above and parallel to the cooking surface. Each ventilator shall utilize three full-length horizontal self draining baffles for centrifugal grease extraction providing a grease extraction rate of up to 95% when operated at design specifications. The use of filters, cartridges or constant running water to extract grease is not acceptable. The baffle at the air inlet shall be a three position damper controlled by an electrically driven actuator, specifically listed for such use. In position number one, the fan on mode, the damper shall be a grease extracting baffle, position two the damper shall be in the wash mode and position number three in the fire mode. Dampers located at the exhaust duct collar are not acceptable. The main grease gutter shall have a 1” slope to the drain opening and the drain shall be equipped with a pre-flush line to purge the drain during the
KITCHEN EXHAUST AND POLLUTION CONTROL

wash cycle. The ventilator shall include a built in 3" air space at the rear for compliance to NFPA-96 when mounting against a limited combustible wall. Continuous front and rear brackets shall be provided to facilitate mounting to the wall and hanging from the overhead structure.

1. (Optional) The ventilator shall include "Custom Air" baffles to reduce the exhaust air volume over specific cooking equipment as indicated on the plans (add suffix "CA" to model number). The ventilator shall operate at air quantities as shown on plans.

2. Automatic Washdown System: The ventilator shall include a full length wash manifold equipped with two rows of brass spray nozzles. When the wash cycle is initiated the exhaust fan is shut off, the damper shall close forward to seal off the air inlet slot exposing the entire grease gutter to the wash sprays. At the conclusion of the wash cycle the damper shall remain closed, in the "System Off" position, preventing conditioned air from escaping the occupied space via thermal drafts, and then re-open when the exhaust fan is started. All controls and components for operation of the wash system shall be housed in the Ventilator Control Cabinet.

3. Internal Fire Protection: The ventilator shall be equipped with an internal fire protection system activated by fail-safe thermostat(s) located at the duct collar. When the temperature of the exhaust air reaches the set point, the fire damper shall automatically close in the direction of the exhaust air flow, sealing against the back wall of the ventilator, and act as a barrier to prevent flame from entering the extraction chamber and duct system. The exhaust and make up air fans shall shut off, and the internal wash system shall be initiated, acting as a deterrent to fire in the extractor and exhaust ductwork. In addition, the internal water sprays shall continuously bathe the fire damper to eliminate warping of the damper during a severe fire condition. The water sprays shall remain on until the thermostat temperature drops below its set point, then stay on for a five minute cool down cycle. At the conclusion of the cool down period the water sprays shall shut off. The damper shall remain closed until the exhaust fan is restarted. A remote fire switch shall be provided and shall be located at an exit. Pulling the fire switch shall turn on the water sprays, open the fire damper to the fan on position and turn on the exhaust fan.

4. Accessibility and Inspection: The ventilator shall be equipped with full-length non-gasketed hinged inspection doors so that service can be performed on fire suppression system nozzles, fusible links, wash system manifolds and nozzles, drains and other interior components without removing any panels, dampers or baffles. No tools shall be required to access the interior of the extraction chamber or plenum. The hinged access doors shall include a baffle that can be fully retracted for ease of access during maintenance, and that also acts as a grease extraction baffle during normal system operation.

5. (OPTIONAL) Ultraviolet Light Section: The ventilator shall include ultraviolet lamps mounted in modules located in the plenum section. There shall be one or more UV modules, as dictated by the ventilator length, and each module shall be on a slide track for easy removal. There shall also be a particulate separator located in the plenum area immediately upstream of the modules. Access to the particulate separator shall be through the ventilator extraction chamber inspection doors. Access to the UV modules shall be through keyed hinged doors, and shall include an interlock switch to shut off the lamps in the event the doors are opened during operation. A pressure switch shall be provided to monitor the airflow to prevent operation of the lamps when the airflow is inadequate. The wash inspection door shall be equipped with an interlocking switch to prevent the operation of the UV lamps if the doors are open. Mounted on the plenum of each ventilator section shall be indicating lights to monitor "UV System On", "Lamp Failure" and "UV Safety Interlock Activated". A duplicate set of these lights shall be mounted on the ventilator control cabinet. The control cabinet shall be equipped with an audible alarm indicating there is a lamp failure or one of the safety interlock switches have been activated.

6. Light Fixtures shall be U.L. Listed Recessed Fluorescent type pre-wired to single point connection on top of the hood. (Optional incandescent type). Wiring shall conform to the National Electric Code (NEC).
KITCHEN EXHAUST AND POLLUTION CONTROL

D. Electrical: The ventilator shall be factory pre-wired to a single connection point. Ventilators built in multiple sections shall be furnished with coiled flex conduit for interconnecting sections by applicable trades.

L. Compensating or short circuit hoods are not allowed

E. Manufacturer: Gaylord or approved equal.

2.3 TYPE II HOODS FOR VAPOR AND ODOR

A. General:
   1. Hood construction: 18 or 16 gauge 300 Series stainless steel with #4 polish. Use of 400 Series stainless, Galvanized steel, or aluminized steel is unacceptable.
   2. Hood(s) shall be equipped with a condensing baffle to drain off extracted moisture and a full perimeter gutter with drain.
   3. Exhaust flows shall be based on NSF Standard No. 2.
   4. The ventilator shall be UL Listed under the category “Exhaust Hood with Exhaust Damper” and listed by NSF. The ventilator shall comply with all requirements of NFPA-96, IMC, UMC, BOCA and SBCCI model codes.
   5. Exhaust flow rate and pressure drop shall not exceed those of the specified product as shown on the drawings used for the base design.
   6. Required options include:
      a. Hood lights
      b. Balancing Damper

2.4 KITCHEN EXHAUST POLLUTION CONTROL SYSTEM

A. Manufacturer: Gaylord ClearAir Pollution Control Unit model number RSPC-ESP in accordance with the following:
   1. The pollution control units shall consist of a smoke control section, odor control section (optional) and exhaust fan section (optional) all built into on a common base as an integral unit. Smoke control shall be accomplished by electrostatic precipitation (ESP). The unit shall be ETL listed and labeled.

B. Products
   1. Smoke Control System
      a. The smoke control section shall contain one or more electrostatic precipitator (ESP) cells to remove smoke particles from the air stream to a level no higher that 20% opacity when operated in accordance with the operation and maintenance guidelines. The ESP cells shall be of a floating plate design to eliminate plate warpage during high heat operation. The cells shall be positioned on slide tracks so that they may be easily removed through a hinged cell access door(s). For ease of handling, individual cells shall weigh less than 54 lbs. There shall be removeable, cleanable debris screens located immediately upstream of the ESP cells and a moisture separator immediately downstream.
      b. An electrical panel mounted on the unit shall contain the high voltage power pack assembly, safety disconnect switch, main disconnect switch, fuses and a magnetic starter for the exhaust fan when fan is included. The safety disconnect switch shall interface with the electrical panel access door such that when opened it will shut off service to the power pack(s) and ground them to drain the residual electrical charge from both the power pack(s) and the ESP cells. The ESP cell door shall interface with the electrical panel access door so that it cannot be opened without first opening the electrical panel access door. The high voltage power pack(s) shall be self-limiting type and shall be self-contained. The electrical panel shall include indicating lights to monitor cell and transformer voltage. The main disconnect switch for the exhaust fan and control circuits shall lock the electrical panel access door closed when in the “on” position. The unit shall contain one or more oscillating wash manifold(s) with Opti-wash spray nozzles to wash the ESP cells with hot detergent injected water each time the exhaust fan is shut-off.
KITCHEN EXHAUST AND POLLUTION CONTROL

2. Control Cabinets
   a. No Wash Option:
      1) The unit shall not include automatic water wash and the ESP cells shall be easily removed for periodic pressure washing. The unit shall be equipped with non-oscillating wash manifolds in the event of adding automatic washing in the future.

   b. Water Wash Option:
      1) Control Cabinet (When Sub Panel is not Used)
         a) The controls and plumbing components for the operation of the Exhaust Fan, ESP, Wash System and Fire Cycle of the Pollution Control Unit shall be an integral part of the Kitchen Exhaust Hood Control Cabinet as specified in Division 11. All inter connecting wiring and piping shall be the responsibility of the appropriate trades.

      2) Control Cabinet and Sub panel Combination
         a) The controls for the operation of the Exhaust Fan, ESP, Wash Systems and Fire Cycle of the Pollution Control Unit shall be an integral part of the Kitchen Exhaust Hood Control Cabinet as specified in Division 11. All plumbing components for the ClearAir unit shall be housed in the Sub Panel. All inter connecting wiring shall be the responsibility of the appropriate trades.

         b) A Sub Panel shall be furnished with the pollution control unit. The Sub Panel shall be constructed of 18 gauge stainless steel, number 4 finish, with welded corners and hinged doors to the plumbing and electrical compartments. The plumbing compartment shall be pre-plumbed with a reduced pressure principle device back flow preventer, shut off valve, pressure/temperature gauge, one or more slow close solenoid valves, detergent pump and detergent flow switch. The electrical compartment shall have a terminal block for single point connection of all electrical components. The detergent container shall be located next to the sub panel and shall be provided by the detergent supplier. The sub panel shall be shipped loose for field installation by the appropriate trades.

3. Odor Control Options
   a. Media bed of 50/50 Blend Potassium Permanganate and Carbon Blend
      1) The unit shall be provided with odor control utilizing a media bed of 50% potassium permanganate/50% carbon blend that is UL class I. The odor removal medial shall be housed in slide out reusable steel modules. There shall be a 30% pleated media after filter located immediately downstream of the odor control media. Replaceable filters shall be mounted in filter slide tracks to prevent air bypass around the ends of the installed filter bank. The odor control media and after filters shall be removable through side access doors with lift and turn latches.

   b. Spay Odor Control
      1) The unit shall be provided with a spray odor control system utilizing an odor neutralizer chemical. The odor spray control cabinet shall be mounted on the side of the unit and shall contain an air compressor piped to the atomizing spray nozzle in the fan plenum, adjustable delay timers with fuse protected circuitry factory wired to the unit electrical panel. The cabinet shall include one 5 gallon container of Gaylord Formula GS-710 Odor Neutralizer. The cabinet shall contain a heater to prevent freezing of the odor neutralizer.
KITCHEN EXHAUST AND POLLUTION CONTROL

4. Exhaust Fan Options
   a. Exhaust Fan (Standard Centrifugal Fan)
      1) The unit shall include a centrifugal exhaust fan. The exhaust fan shall be an SWSI up blast arrangement #9 or #10 with a non-overloading BI, AF or FB wheel. The motor, drives, bearings and fan mounting base shall be located out of the exhaust air stream as required by the IMC (international Mechanical Code) and NFPA-96. The fan shall be AMCA certified and bear the AMCA seal for performance. The fan shall be UL 762 listed. The fan housing shall be constructed of heavy gauge steel. The fan bearings be heavy-duty self-aligning pillow block type rigidly mounted on heavy structural steel supports. The motor shall be ODP three phase mounted on a common base with the fan and shall be pre-wired to the electrical cabinet located on the unit. The electrical cabinet shall include a disconnect switch, motor starter, overloads and fuses. The factory provided drive assembly shall be adjustable pitch on 5HP and smaller, fixed pitch on 7.5 HP and larger. It shall also be sized for a minimum 1.5 service factor. After final system balancing, fixed pitch sheaves shall be provided and installed by the air balancing contractor to provide proper flow at actual installed conditions.

   b. Exhaust Fan (Optional Tubular Fan)
      1) The unit shall include a tubular centrifugal exhaust fan. The exhaust fan shall be an arrangement #10 with a non-overloading BI, AF wheel. The motor, drives, bearings and fan mounting base shall be located out of the exhaust air stream as required by the IMC (international Mechanical Code) and NFPA-96. The fan shall be AMCA certified and bear the AMCA seal for performance. The fan shall be UL 762 listed. The fan housing shall be constructed of heavy gauge steel. The fan bearings shall be heavy duty rigidly mounted on heavy structural steel supports. The motor shall be ODP three phase mounted on a common base with the fan and shall be pre-wired to the electrical cabinet located on the unit. The electrical cabinet shall include a disconnect switch, motor starter, overloads and fuses. The factory provided drive assembly shall be adjustable pitch on 5 HP and smaller and fixed pitch on 7.5 HP and larger. It shall also be sized for a minimum 1.0 service factor. After final system balancing, fixed pitch sheaves shall be provided and installed by the air balancing contractor to provide proper flow at actual installed conditions.

   c. Exhaust Fan Housing
      1) The exhaust fan section of the unit shall be enclosed with the same material as the smoke control section. There shall be a removable panel for access to the fan.

C. Internal Fire Detection
   1. The unit shall be equipped with a thermostat(s), set at 250°F, the system control goes into a fire mode. The fire mode shall shut off the exhaust fan, activate the kitchen hoods wash sprays, and turn on the wash sprays in the pollution control unit.

D. Unit Construction
   1. The unit housing shall be constructed of a minimum of 16 gauge G90 bright galvanized steel. The perimeter base shall be 12 gauge formed channel with lifting lugs at each corner and along the length as required. The housing shall be externally welded liquid tight for compliance to the International Mechanical Code and NFPA-96 grease duct construction requirements.

E. Accessories Options
   1. Spare ESP cells
   2. The unit shall be supplied with a minimum of one extra ESP cell of each type of cell and one soak tank. The soak tank shall be constructed of 18 gauge stainless and shall be
KITCHEN EXHAUST AND POLLUTION CONTROL

3. Detergent

F. Fire Extinguishing System Options
   1. Wet chemical system
      a. Provide a complete factory mounted Ansul wet chemical fire extinguishing system, including nozzles piping and detection runs. Pipe penetrating the unit cabinet shall use a UL listed fitting. System shall be installed in accordance with the systems listing and NFPA-96. The Ansul Automan cabinet shall be mounted on the side of the unit for easy access, certification and service. If the unit is exposed to freezing condition, the Ansul Automan cabinet shall be mounted in an insulated thermostatically controlled heated cabinet.

   2. Water spray sprinkler fire system
      a. Provide a pre-piped water spray fire system installed in accordance with NFPA-96. The unit shall be piped with one pendent type sprinkler nozzle located in the smoke control section, one in the odor control section, if equipped with 50/50 media bed, and one in the exhaust fan section for interconnection to the building sprinkler system by appropriate trades. Pipe penetrating the unit cabinet shall use UL listed fitting. Nozzles shall be the bulb type rated at 325°F.

PART 3 - EXECUTION

3.1 POLLUTION CONTROL UNIT CHECK OUT AND DEMONSTRATION
   A. Upon completion of installation, the pollution control system, including the kitchen exhaust hoods, shall be commissioned by a factory certified service technician. Start-up shall include checking all ESP cells, filters, high voltage components, exhaust fan, control cabinets and sub panels as well as running the system through wash and fire cycles. The appropriate maintenance personnel shall be given a technical manual and a complete demonstration of the system, including operation and maintenance procedures. Upon completion of the commissioning, a detailed start-up report shall be made available to the architect and owner certifying proper system operation. Changes required in fan drive components shall be preformed by the air balancing contractor per instruction of the manufacturer's start-up representative.

3.2 SUGGESTED HOOD INSTALLATION CRITERIA:
   1. Hood mounting height: Hood front must be from 6’8” to 7’0” above finished floor as required by codes.

   2. Overhang: The inside of the hood should project not less than 12 inches beyond cooking surfaces for wall hoods 18° over ovens. Wall hood length should extend not less than 6 inches beyond ends of cooking surfaces. (The use of end skirts can eliminate Can reduce the air flow requirements.) 12° overhang on all sides recommended for island hoods. 18° overhang over ovens.

   3. Use plenum boxes for make up air in the ceiling at the front of the hood.

   4. Use transfer air that would be exhausted from the dining space when ever possible to reduce the amount of dedicated make up air for the kitchen exhaust hood.

3.3 INSTALLATION
   A. Install in accordance with manufacturer's instructions.

   B. Examine site to verify if site is ready to receive work. Provide layout drawings of air handlers and fan locations to electrical installer.

   C. Install unit on vibration isolators.

   D. Control installers shall install all wiring associated with control signals into the air handlers.
KITCHEN EXHAUST AND POLLUTION CONTROL

E. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 16 work.

3.4 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SUMMARY
1 Section Includes:
   a. Constant-air-volume, single-zone air-handling units.
   b. Constant-air-volume, multizone air-handling units.
   c. Constant-air-volume, dual-duct air-handling units.
   d. Variable-air-volume, single-zone air-handling units.
   e. Variable-air-volume, dual-duct air-handling units.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230902: Variable Frequency Drives (VFD)
D. Section 233113: Air Distribution
E. Section 234100: Air Filtration
F. Division 26: Electrical

1.4 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of \[
\frac{L}{200} \quad \text{or} \quad \frac{L}{100} \quad \text{<Insert value>}
\] where "L" is the unsupported span length within completed casings.
C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7<Insert requirement>.
   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]."

1.5 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."
C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 Standards Handbook
      b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
      c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
      d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
CUSTOM FACTORY AIR HANDLING UNITS

e. 500 Test Method for Louvers, Dampers, and Shutters

   a. 9 Load Ratings and Fatigue Life for Ball Bearings
   b. 11 Load Ratings and Fatigue Life for Roller Bearings
   c. 900 Test Performance of Air Filter Units

3. Air-Conditioning and Refrigeration Institute (ARI):
   a. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
   b. 430 Central-Station Air-Handling Units

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 Safety Code for Mechanical Refrigeration

5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.

6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 National electrical Code
   b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors’ National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

9. Units shall be listed and labeled by either UL or ETL for air handler construction.

1.6 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:

1. The proposed substitution does not affect dimensions shown on drawings.
2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.7 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air handling units showing
   1. Dimensions and weights
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fan including:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories.
      d. Motor ratings, electrical characteristics, and motor accessories.
      e. Fan assembly vibration and balance test report.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Retain both subparagraphs below if items are furnished as parts of air-handling units.
CUSTOM FACTORY AIR HANDLING UNITS

6. Dampers, including housings, linkages, and operators.
7. Filters with performance characteristics.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of one half inch to one foot. Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.8 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For air-handling units, 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.

B. Source quality-control reports.

C. Field quality-control reports.

1.9 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.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer’s stamp or label affixed.

B. Store and protect unit against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.11 WARRANTY

A. Provide one-year (12 months) warranty from date of startup or 18 months from date of shipment, whichever occurs first. The manufacturer’s warranty shall include parts and labor to provide factory authorized service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Energy Labs or approved equal by HuntAir, Innovent, Alliant, or Haakon Industries. By listing manufacturers it is not intended to imply that their standard construction is approved or that they are equal. All manufacturers must meet, or exceed, minimum requirements of these specifications and all other standard or optional features provided by the scheduled basis of design air handler.

2.2 GENERAL

A. Any exceptions to the specifications must be clearly defined in the submittal process. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

B. Fabricate draw-thru or blow-thru type air handling units suitable for the scheduled air pressure operation as indicated.

C. Fabricate units with: fan sections as noted; coil section(s); heat recovery sections, mixing section; filter section(s); access section(s); discharge plenum; bellmouth duct connections; variable
CUSTOM FACTORY AIR HANDLING UNITS

frequency drives; dampers; lights and vestibules. Fabricate unit in split sections for field assembly if necessary.

D. Vestibule piping requirements: If shown on plans all piping located within the air handler vestibule is to be supported as specified. Mechanical Contractor to coordinate with air handler supplier to insure that all supports are provided and that adequate structural reinforcement is provided within the air handler to accommodate the operational weight of the pipe supported. The Mechanical Contractor is to provide the air handler manufacturer with an approved shop drawing indicating the location and weight of all equipment and the location of all piping and pipe penetrations located in the air handler vestibule prior to the design of the air handler by the manufacturer.

E. Fans shall be selected for variable volume operation. The scheduled fan arrangement and unit configuration is the basis of selection. Alternate configurations which are equal or smaller in size and weight, energy and acoustic performance will be considered. Include information indicating pertinent differences, either positive or negative, to base design indicated on documents. Unit component face velocity to remain as designed to conserve motor horsepower. The mechanical contractor and supplier shall bear all costs for redesign of mechanical, plumbing, electrical, structural, architectural and controls that may be associated with the revised configuration. Provide analysis of unit power consumption for code compliance.

F. Factory fabricate and test air handling units of sizes, capacities, and configuration as indicated and specified.

G. All major components used to assemble air handling units with the exception of electrical devices, drives, bearings and controls shall be manufactured by the air handler manufacturer.

H. Motors shall be inverter duty NEMA MG-1 premium efficiency TEFC type. All wiring shall be routed to a single external junction box for each fan section. See Section 230902 for additional requirements.

I. Filter section shall include space for face load or side access slide-in filters with 2" or 4" pre-filters and 22" bag type final filters with an average efficiency of 85% per ASHRAE Standard 52-76 test.

J. Provide measurement arrays as described below.

2.3 UNIT CASING

A. Walls and roofs shall be constructed of 16 ga., G90 galvanized steel 4" thick panels. The inner wall shall be a minimum of 22 ga., solid galvanized steel in all sections except fan inlet and fan section which may be perforated metal. The wall panels shall be insulated with 4", 3.0 lbs/cu. ft rigid neoprene coated insulation. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 1/8" x 3/8" tape sealer. Wall seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.

B. All panels shall be joined using bolts rather than sheet metal screws.

C. All insulation edges shall be protected with metal lagging. Insulation systems using stickpins or adhesives are not acceptable.

D. Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection, additional internal reinforcing shall be added.

E. Provide duct bellmouth fittings where dimensions allow. Provide walk able grates over all duct floor penetrations, maximum pressure loss not to exceed 0.10-inches WC.

F. Acoustical Performance:
   1. The housing shall have been tested for acoustical performance by an independent laboratory that is accredited.
   2. Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73.
b. Test methods and facilities used to establish sound absorption values shall conform explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption Coefficients by the Reverberation Method: ASTM C423-84A and E795-83.


4" Walls 

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot; Walls</td>
<td>0.40</td>
<td>0.65</td>
<td>1.38</td>
<td>1.28</td>
<td>1.09</td>
<td>1.05</td>
<td>1.02</td>
<td>1.02</td>
</tr>
</tbody>
</table>

NRC = 1.20

d. Submit lab report for approval.

2.4 **BASE CONSTRUCTION**

A. Units shall be constructed from structural steel C-channel around the perimeter of the unit with intermediate channel, angle or tube supports.

1. Channel bases shall be sized as a function of air handling length as follows:

<table>
<thead>
<tr>
<th>A.H. UNIT LENGTH</th>
<th>MINIMUM CHANNEL SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP to 10</td>
<td>4&quot; x 1-5/8&quot;</td>
</tr>
<tr>
<td>11’ to 20’</td>
<td>6&quot; x 2&quot;</td>
</tr>
<tr>
<td>21’ to 30’</td>
<td>8&quot; x 2-1/2&quot;</td>
</tr>
<tr>
<td>41’ to 50’</td>
<td>12&quot; x 3&quot;</td>
</tr>
</tbody>
</table>

(5.4lbs/Lin.Ft.)

(8.2lbs/Lin.Ft.)

(11.5lbs/Lin.Ft.)

(20.7lbs/Lin.Ft.)

B. Floor shall be flat, reinforced from below, with all seams continuously welded. OR Floor shall be 0.12" checker plate installed on the base. Drive screw attachment and caulking are not acceptable. The base shall be provided with lifting lugs, a minimum four per unit section. The base shall be insulated tight to the floor with 4", 3.0 lbs/cu. ft fiberglass insulation. The insulation is to be protected with 22 ga. solid galvanized steel liner if the unit floor is exposed in a suspended application. Floors that "oil can" are not acceptable.

C. Floor insulation shall be installed beneath the floor panels in the same manner as the wall and ceiling insulation.

D. Condensate Drain Pans:

1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

2. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1 <Insert distance>.

3. Depth: A minimum of 2 inches (50 mm) <Insert depth> deep.

4. Integral part of floor plating


6. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on [one end] [both ends] of pan.

7. Minimum Connection Size: [NPS 1 (DN 25)] [NPS 2 (DN 50)] <Insert size>.

8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
CUSTOM FACTORY AIR HANDLING UNITS

9. The manufacturer shall provide a 1.5" perimeter collar around the entire unit and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 1.5" of water.

10. The manufacturer shall provide auxiliary drains in mixing and OSA intake sections.

11. All drain connections on floor mounted air handling units shall terminate at the side of the unit.

E. Maximum base deflection shall be 1/4" on 20 ft unsupported span.

F. Maintenance Rails: Provide overhead lifting rails in sections where motor service will be required.

2.5 INSPECTION AND ACCESS PANELS AND ACCESS DOORS:

A. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.

B. Inspection and Access Panels:
   1. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
   2. Gasket: Neoprene, applied around entire perimeters of panel frames.
   3. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

C. Access Doors:
   1. Hinges: A minimum of two ball-bearing hinges and two roller cam-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   2. Gasket: Neoprene, applied around entire perimeters of panel frames.
   3. Fabricate windows in [fan section] doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
   4. Size: The minimum door clearance shall not be less than 19"x 70" (where unit height permits) and shall be large enough to allow the largest assembled internal component to be removed through the doorway. Internal components must have a door of minimum width to remove the assembled components. Vestibule doors to the exterior shall be 42"x70" (where unit height permits).

D. Locations and Applications:
   1. Verify that the sections listed below are large enough for panels and doors. Verify applicability with listed manufacturers.
   2. Fan Section: [Inspection and access panels] [Doors] [Doors and inspection and access panels].
   3. Access Section: Doors.
   4. Coil Section: Inspection and access panel.
   5. Damper Section: [Inspection and access panels] [Doors].
   6. Filter Section: [Inspection and access panels] [Doors] large enough to allow periodic removal and installation of filters.
   7. Mixing Section: Doors.
   8. Humidifier Section: Doors.

2.6 FAN, DRIVE, AND MOTOR SECTION

A. All fans shall be tested in accordance with AMCA Standard 210-70 Test Code for Air Moving Devices. Fans shall bear the AMCA sticker for both air and sound performance.

B. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
   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. Hollow shafts are unacceptable.
CUSTOM FACTORY AIR HANDLING UNITS

b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range. The critical speed will be based on the top of the speed range for the fans’ AMCA class. The lateral static deflection shall not exceed 0.003” per foot of the length of the shaft.

2. Fan assembly shall be balanced per ISO standard G6.3 with a copy of the balance test data for this project with deflection and critical speed of the shaft and wheel submitted to the engineer.

C. 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 (89 mm)] [5-3/4 inches (146 mm)] wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet or 0.032-inch- (0.8-mm-) thick aluminum sheets; select metal compatible with casing.
         1) Fabric Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
         2) Fabric Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
         3) Fabric Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

D. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
   1. Arrangement #4 direct drive fans or AMCA Arrangement #1 either horizontal or vertical as shown on plans and drawings. There shall be no obstructions (i.e., bearings or bearing supports, etc.) at the inlet of the fan. Fan wheel shall be aluminum with aluminum extruded airfoil blades. The fan inlet on plenum fans shall be isolated from the cabinet by means of a neoprene-coated flexible connection. Plenum fans shall be provided with spring-style thrust restraints.
      1. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule. The fan shall be constructed to AMCA Standards for the Class Rating as indicated on the Equipment Schedule.

E. 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. Aluminum wheel.

F. Fan Array Installation:
   1. Provide individual fan back draft dampers and acoustical treatment.
   2. Each fan and motor shall be mounted on an all welded, structural steel, prime coated, internal isolation base with springs selected to provide 99% isolation efficiency with minimum 1” deflection. The inlet of the fan shall be separated from the unit casing by means of a factory installed flexible fabric connection. Provide unit mounted red LED indicator lights to monitor status of all fan array fans, one light per fan. LED to light up indicating loss of respective fan operation. Label lights “FAN FAILURE LIGHTS”.

G. Fan Shaft Bearings:
   1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L10 rated life of 200,000 hours according to ABMA 9. Bearings are to be mounted on the fan.
H. Internal Vibration Isolation and Seismic Control:

1. Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of [1 inch (25 mm)] [2 inches (50 mm)] <Insert value>.

2. 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 Section 230548 "Vibration Isolation and Seismic Restraint for Piping, Ductwork, and Equipment" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.

3. Fan Assembly Testing:
   a. Following assembly, the fan balance shall be tested using an electronic balance analyzer with tunable filter and stroboscope.
   b. Direct drive fan wheels shall be factory dynamically balanced and shall meet or exceed guidelines in AMCA 204-96 for Balance Quality and Vibration Levels for Fan Application Category BV-5. Following fan assembly, the complete spring isolated fan assembly shall be tested using an electronic balance analyzer with tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 Axial). The maximum allowable velocity shall not exceed 0.125 inches per second peak amplitude (filter in) on any of 5 readings and shall not exceed .5 mils @ 1170 rpm.
   c. A copy of the Vibration test report (Vibration Nomograph) shall be provided with the Operation and Maintenance Manual upon request. The fan assembly shall also be vibration tested at design RPM with the spring isolators at the specified deflection, with the tunable filter utilized and frequencies from 500 cpm to 50,000 cpm shall be scanned to detect misalignment, bearing defects, mechanical looseness or foundation weakness. A copy of the balance test data for this project showing calculations for deflection and critical speed of the shaft and wheel assembly shall be submitted to the engineer review.

4. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   a. Enclosure Type: Totally enclosed, fan cooled.
   b. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   c. 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.
   d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   e. Mount unit-mounted disconnect switches on [exterior] [interior] of unit.

2.7 COILS

A. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall be mounted in the unit casing to be accessible for service and can be removed from the unit through the side. Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410-81.

B. Coils shall be fully enclosed within casing and mounted on primed and painted angle iron racks manufactured to allow coils to slide out individually. Cooling coil racks shall be primed with zinc rich chromate primer. Racks to be designed to allow coil removal from the face of the coil rack. All coils to be removable from either side of the unit by easily removable end panels. End panels that open to coil header and return bend section shall be installed with drive screws and nut-serts to allow access to header and return bend sections for coil inspection without disruption to unit air seal.
CUSTOM FACTORY AIR HANDLING UNITS

Individual end panels to be supplied for each coil on the supply and return side of the cabinet to allow single coil piping breakdown for coil removal.

C. Coil penetrations through cabinet shall be grommeted, sealed airtight by a double escutcheon plate on the exterior of the casing. The escutcheon plate shall have a rolled collar around the pipe opening to protect the pipe and be equipped with an “O” ring rubber gasket between the collar and the pipe to prevent chaffing and provide an air tight seal around the opening. All supply and return connections shall be plainly and permanently marked.

D. Both ends of the coil to be sealed off from the main air stream by full height blank-offs on both the entering-air and leaving-air sides. Blank-offs to be the same material as the coil casing. Headers and return bends to be further insulated with a closed cell neoprene gasket the full height and width of the coil casing to reduce condensation.

E. Drain pans shall be continuously welded type 304 stainless steel. Intermediate drain pans shall be interconnected with 1 in. stainless steel drain lines. Drain pans shall be sloped and fully drainable.

F. Coils shall be designed for chilled water, heat recovery or hot water service and be of the counter flow design.

G. All coils shall be fabricated of 5/8" O.D. seamless copper tubing of 0.020 wall thickness minimum mechanically expanded into aluminum fins of 0.008 minimum thickness. All return bends shall be 0.035 copper minimum. Headers shall be of seamless copper. Supply and return connections on each coil shall be raised/lowered a minimum 6" from the bottom/top of the coil to allow room for piping connection hookup between stacked coils, coils near floors and coils near roofs. Each coil shall be provided with capped vent and drain connections extended to the exterior of the cabinet. All coils shall be fully drained with no trapped tubes. Coil casing to be 304 stainless steel for cooling coils and 16 ga galvanized for heating coils.

H. Coils shall be hydrostatically tested at 400 psi, and shall be suitable for working pressures and temperature up to 200 psi and 220 degrees F.

I. Pipe connections shall be on the same end, and shall be threaded. On units with split coils, extend coil pipe connections from coil header through unit side casing using specified pipe material.

J. Water coils handling recently mixed air, or direct outside air, shall be fully drainable by removing a single threaded plug for each coil row.

K. Coils indicated as being cleanable shall have either a cleanout plug for each tube or shall have a gasketed removable header cover.

L. On cooling coils and heat recovery coils using vertically corrugated fins or spiral wound fins, provide moisture eliminators on the downstream side of cooling coils and heat recovery coils when the face velocity exceeds 550 fpm. On cooling coils and heat recovery coils using horizontally corrugated fins, provide moisture eliminators when the face velocity exceeds 525 fpm. Moisture eliminators shall be 304 stainless steel, 3-break type draining directly into the cooling coil drain.

2.8 FILTERS

A. Provide pre-filters and front loading final filters.

B. Filter Gauges
   1. The manufacturer shall provide a DWYER (0-2 inch, 0-500 Pa) magnehelic gauge.
   2. Magnehelic gauges shall be accurate to +/- 2% of full range.
   3. One gauge shall be provided for each type of filter in filter bank.
   4. Gauges shall be recessed into the cabinet casing with a weather cover.

2.9 FINISH

A. Factory Applied Finish for [Steel] [and] [Galvanized-Steel] Casings:
2. Casing Coating: [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel] <Insert special coating>.

2.10 ALUMINUM AIRFOIL DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 5 percent of air quantity at 2000 fpm face velocity through damper and 3-inch wg (1000-Pa) pressure differential.

B. Aluminum airfoil frames and blades shall be a minimum of 12 gauge extruded aluminum. Blades shall be of a single unit airfoil design 6" wide.

C. Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames shall be 2" x 4" x 5/8" on the linkage side, 1" x 4" x 1" on the other 3 sides.

D. Pivot rods shall be 7/8" hexagon extruded aluminum interlocking into the blade section. Bearings shall be of a double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into the frame to prevent the outer bearing from rotating.

E. The bearing shall be designed so there are no metal-to-metal or metal-to-bearing riding surfaces. The interconnecting linkage shall have a separate Celcon bearing to eliminate friction inside the linkage.

F. Blade linkage hardware shall be installed in a frame outside the airstream. All hardware shall be of non-corrosive, reinforced cadmium plated steel.

G. Multiple damper motors are to be used rather than jack shaft assemblies.

H. Dampers shall be Ruskin #CD50, T.A. Morrison #1000, or equivalent.

2.11 SOUND POWER LEVELS

A. Air handling unit sound power levels shall be submitted for review. Sound power data shall be given at the supply connections and return connections in addition to radiated sound power from the cabinet. Raw fan sound power data shall be derived from testing on the identical fans as used in the units. Data extrapolated from different fans is not acceptable.

B. Attenuation assumed for cabinet configuration, type of insulation, opening location and sizes shall be verified through actual test measurements. All measurements shall be performed in an AMCA certified laboratory in accordance with AMCA standard 300 of ASHRAE 12.12. These test reports will be submitted to the Architect before units ship from the factory.

2.12 VARIABLE FREQUENCY DRIVES

A. Both supply and return fans are to be powered by drives complete with bypass starter section. See Section 230902 for additional requirements.

2.13 FLOW MEASURING PROVISIONS

A. Fan flow measurement: Supply and return fan inlets shall be provided with factory-mounted airflow measuring devices. This device shall not obstruct the inlet cone to the fan, nor add any pressure losses or sound level increases to the fan performance.

B. Outside Air Measurement:
   1. Configure Outside Air Intake dampers:
      a. If the outside air intake dampers are sized for 100% fresh air capability configure the dampers to enable separate control and measurement of the minimum outside air required for the project area served by the AHU.
   2. Provide a minimum outside airflow measuring station:
      a. If the AHU is installed on the interior with ducted fresh air, install the measuring station in a straight duct section upstream from the minimum outside air dampers and interfacing control for providing an electronic signal for use by the control contractor in controlling a minimum outside airflow and temperature.
CUSTOM FACTORY AIR HANDLING UNITS

b. If the AHU is an outdoor mounted unit, the minimum outside airflow measurement station is to be factory mounted on the exterior side of the outside air intake in a protective weatherhood.

C. Sensor Performance:
1. Fan Airflow Installation:
   a. Installed airflow accuracy: +/- 3% to 10% of reading with +/- 0.25% repeatability.
   b. Sensor probe performance: +/- 2% of reading, 0-5000 fpm, 0.15°F temperature accuracy +/-.
2. Outside Air Installation:
   a. Installed airflow accuracy: +/- 2% of reading with +/- 0.25% repeatability.
   b. Sensor probe performance: +/- 2% of reading, 0-5000 fpm, 0.15°F temperature accuracy +/-.

D. Transmitter:
1. Flow measuring array to include a transmitter for flow and temperature analog output signal for the building energy management system in either 4-20 mA or 0-10VDC, or BACnet digital compatible. Coordinate signal output with controls installer.
2. Transmitter to include an airflow gauge to provide direct readout in cfm. Mount on the outside of the air handler if air handler is located in a mechanical room. Mount in a NEMA 3R control cabinet if located outside.
3. Device to provide switch selectable Modbus or Johnson N2 outputs. Device to be UL listed.

E. Airflow measuring station to be by Ebtron. KURZ, Fluid Components and Sierra Instruments are acceptable with temperature readout and UL listing.

2.14 ELECTRICAL

A. Each fan motor shall be wired to its respective VFD provided by fan manufacturer integral to unit. See Section 230902 and 2.1, G above for requirements.

B. All wiring shall be 6600 volt rated type XLPE, RW90 stranded copper, enclosed in conduit run internal to the unit. All junction boxes shall be CSA approved. Three phase loads to be color coded for phase matching.

C. All unit VFD's shall be wired to a surface or recessed mounted vestibule electrical panel for a single point three phase power connection provided by Division 26. Control panel shall be NEMA Type 3R enclosure with a single hinged access door. The control panel shall include:
   1. Non-fused main disconnect switch, lockable in the off position
   2. Dual element fuses
   3. Distribution block

D. All wiring shall be numbered, and all remote connection terminals and components in the control panel shall be identified by tag suitable attached. Wiring diagram shall be provided for each unit showing all components, wire number and remote connection terminals.

E. Electrical wiring for lighting and power supply to fan motors shall be run in separate conduits internal to the unit. No external conduit runs are permitted. If the unit requires section splits, junction boxes shall be furnished at each section to allow the electrical contractor to make final connections in the field. Wiring to be clearly labeled at junction points to facilitate reconnection. Air handler manufacturer shall allow a minimum 1.5" clearance above the entire width of each interior bulk headers (coils, filters, fan blank-off, etc.) for field-wiring of any 110v or 24v runs internally to the unit as required by the controls contractor and reduce the number penetrations of the exterior panels.

F. All electrical wiring and components shall be installed to conform to NEC and UL listing requirements. Provide a UL or ETL listing and label for the entire air handler.

2.15 LIGHTS
CUSTOM FACTORY AIR HANDLING UNITS

A. Provide vapor-proof marine grade lights with protective metal cage, sealed glass enclosure and 150-watt compact florescent light for each section containing an access door and for unit vestibule. Duplex receptacles shall be installed at the light switch at each fan section and unit vestibule.

B. A switch with an indicator light shall be installed on the unit controlling both lights and receptacles. Electrical power shall be 120V/1/60 and wired by fan manufacturer to a junction box in the unit vestibule for a single point one phase connection by Division 26.

2.16 HUMIDIFIERS

A. Steam Grid Humidifier:
   1. Manifold:
      a. ASTM A 666, Type 304 stainless steel.
      b. Steam jacketed.
      c. Insulated with 1/2-inch (13-mm) fiberglass and stainless-steel jacket.
      d. Manifold shall extend the full width of unit with mounting brackets at ends.
   2. Steam Separator: [Cast iron,] [ASTM A 666, Type 304 stainless steel,] with [separate humidifier control valve.
   4. Humidifier Control Valve: Actuator: As specified in Section 230900 "Building Automation System (BAS) Controls."
   5. Steam Trap: Inverted-bucket type, sized for a minimum of three times the maximum rated condensate flow of humidifier at 1/2-psig (3.4-kPa) inlet pressure.
   6. Aquastat: For separate mounting on steam condensate, return piping to prevent cold operation of humidifier.
   7. Strainer: In-line type.
   8. Airflow Switch: To prevent humidifier operation in the absence of airflow.

B. Wet Glass Cell Washer Section:
   1. 3-inch- (75-mm-) deep cells with random packed, glass-fiber media in [galvanized] [stainless]-steel frames.
   2. Access Door: Watertight with brass fittings[, wire glass window,] and locking handles.
   3. Spray Tree Assembly: [Brass] [Stainless-steel] nozzles and [galvanized] [stainless]-steel piping.
   4. Eliminator: [Galvanized] [Stainless]-steel plates.
   5. Tank:
      a. Welded[ stainless] steel[, with interior and exterior surfaces blasted and painted with zinc-chromate paint].
      b. Copper suction screen.
      c. Drain, overflow, and suction connections.
      d. Makeup connection with [brass] float valve, and with quick-fill connection.
   6. Insulate exterior with duct insulation and mount on 2-inch (50-mm-) thick, rigid insulation board.

C. Evaporative Humidifier Section:
   2. Spray Tree Assembly: Brass nozzles and galvanized piping, [galvanized eliminator plates with flooding nozzles and header, and galvanized antisplash baffles] [cross-fluted cellulose media].
   3. Tank:
      a. Welded steel tank with interior and exterior surfaces blasted and painted with zinc-chromate paint.
      b. Copper suction screen, drain, overflow, and suction connections.
      c. Makeup connection with [brass] float valve, and with quick-fill connection.
   4. Insulation: Insulate with duct insulation on exterior and mount on 2-inch (50-mm-) thick, rigid insulation board.
CUSTOM FACTORY AIR HANDLING UNITS

2.17 AIR-TO-AIR ENERGY RECOVERY

A. Heat Pipe:
   1. General:
      a. Furnish heat recovery unit of the air-to-air heat pipe exchanger type as shown in
         the equipment schedule.
      b. Heat recovery unit shall require no continuously moving parts for heat transfer
         between exhaust and supply air streams.
   2. Heat Exchanger Construction
      a. Tube core shall be seamless aluminum tubing permanently expanded into the fins
         to form a firm, rigid and complete metal pressure contact between the tube and fin
         collar at all operating conditions.
      b. Secondary surface shall be continuous plate type aluminum fins of corrugated
         design to produce maximum heat transfer efficiency.
      c. Basic capillary wick shall be an integral part of the inner wall of the tube to provide
         a completely wetted surface for maximum heat piping capacity with minimum heat
         transfer resistance.
      d. Refrigerants used shall be classified as Group 1 in ANSI Safety Code for
         Mechanical Refrigeration.
      e. A vertical partition shall be provided, and located as specified in the schedule, to
         isolate the exhaust and supply airstreams from each other to prevent cross-
         contamination.
      f. Heat exchanger pressure drop shall be no more than 0.8” w.g. at rated cfm and
         have an efficiency of no less than 68% at rated flow conditions.
   3. Manufacturer:
      a. Colmac, QDOT, IEC, Des Champs Labs, CTSI or approved equal.

2.18 AIR LEAKAGE TESTING

A. Before shipment the unit manufacturer shall factory pressure test (positive pressure) each air
   handling unit to ensure the leakage rate of the casing does not exceed 1.0% of the unit air flow at
   1.5 times the rated static pressure. Testing shall be done on one unit of each type.

B. The test shall be conducted in accordance with SMACNA duct construction manual. A calibrated
   orifice shall be used to measure leakage airflow.

2.19 SOUND POWER LEVELS

A. Air handling unit sound power levels shall be submitted for review. Sound power data shall be given
   at the outlet connections and inlet connections in addition to cabinet radiated sound power. Raw fan
   sound power data shall be derived from testing on the identical fans as used in the units. Data
   extrapolated from different fans is not acceptable.

B. Attenuation assumed for cabinet configuration, type of insulation, opening location and sizes shall
   be verified through actual test measurements. Sound power data is tested at the factory by an
   acoustical engineer in complete accordance with ARI 260-2001, “Sound Rating of Ducted Air
   Moving and Conditioning Equipment”. These test reports will be submitted to the Architect before
   units ship from the factory.

C. When operating at the maximum design capacities, the tested sound power values shall not exceed
   the values scheduled in the following table.

<p>| Table 1: Maximum Allowable Sound Power Values per ARI 260 in dB re 1 picowatt |
|-----------------------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|</p>
<table>
<thead>
<tr>
<th>Unit ID</th>
<th>Source</th>
<th>Test</th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1K</th>
<th>2K</th>
<th>4K</th>
<th>8K</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARI 260</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARI 260</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
D. Fans to be tested in complete accordance with AMCA 300-1996, “Reverberant Room Method for Sound Testing of Fans”, in a testing laboratory certified by AMCA to perform the test for both 210 performance and 300 sound. When operating at the maximum design capacities, the tested sound power values shall not exceed the values scheduled in the following table.

**Table 2: Casing Radiated Maximum Allowable Sound Power Values per AMCA 300 in dB re 1 picowatt**

<table>
<thead>
<tr>
<th>Fan ID</th>
<th>Fan Type</th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1K</th>
<th>2K</th>
<th>4K</th>
<th>8K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

A. Install in accordance with manufacturer’s instructions.

B. Examine site to verify if site is ready to receive work. Provide a layout drawing of air handler and fan locations to electrical installer.

C. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

D. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

A. Air Handler Mounting:

1. Base Mounted: Install air-handling units on equipment base as described and specified elsewhere
   a. Concrete: Comply with requirements for equipment bases and foundations specified in [Section 033000 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]
   b. If return fans are configured to drawing inlet air from a raised curb, curb access must be provided for field installation and service of measuring devices and smoke detectors.

2. Suspended Mounting: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers.

3. Isolation and Seismic Control: Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

4. Arrange installation of units to provide access space around air-handling units for service and maintenance.

5. LEED-NC, LEED-CI, and LEED for Schools Credit IEQ 3.1 and LEED-CS Credit IEQ 3 require filters with a minimum MERV 13 rating for the air delivered to the occupied space.
CUSTOM FACTORY AIR HANDLING UNITS

Air-handling units should not be used for temporary heating and ventilating unless expressly approved by Owner. If used during construction, see SMACNA's "IAQ Guidelines for Occupied Buildings under Construction" for procedures to protect HVAC system.

6. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

7. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

B. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to air-handling unit to allow service and maintenance.

D. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

E. Connect condensate drain pans using [NPS 1-1/4 (DN 32)] <Insert pipe size>, ASTM B 88, Type M (ASTM B 88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

F. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232113 HVAC Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

G. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232213 HVAC Piping." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

H. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

I. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Section 233113 "Metal Ducts" and Section 233300 "Air Duct Accessories."

J. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233113 "Air Distribution."

K. Control installers shall install all wiring associated with control signals into the air handlers.

L. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

M. Airflow measuring arrays installed in fan inlet volutes must be designed to withstand velocities encountered in this location. Mounting system is to be warranted against failure and consequent fan damage.

3.4 START-UP SERVICES

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
CUSTOM FACTORY AIR HANDLING UNITS

2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Retain first subparagraph below for units with automatic roll filters.
5. Automatic-Roll-Filter Operational Test: Operate filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating.
6. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
7. Retain last subparagraph above or two subparagraphs below for units with HEPA filters. Retain subparagraphs below in critical applications per ASME N510.
8. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
9. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.[ Replace fan and motor pulleys as required to achieve design conditions.]
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

C. ADJUSTING
1. Adjust damper linkages for proper damper operation.
2. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
CUSTOM FACTORY AIR HANDLING UNITS

D. CLEANING
   1. After completing system installation and testing, adjusting, and balancing air-handling unit
      and air-distribution systems and after completing startup service, clean air-handling units
      internally to remove foreign material and construction dirt and dust. Clean fan wheels,
      cabinets, dampers, coils, and filter housings, and install new, clean filters.

E. DEMONSTRATION
   1. Engage a factory-authorized service representative to train Owner's maintenance
      personnel to adjust, operate, and maintain air-handling units.

3.6 AIR HANDLING UNIT CONFORMANCE

A. Manufacturer representative shall complete the following table and provide a copy with each
   submittal package to assure conformance to specifications:

B. Air Handler COMPLIANCE Checklist:

<table>
<thead>
<tr>
<th>AIR HANDLER PERFORMANCE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Dimensions (LxWxH inches)</td>
<td></td>
</tr>
<tr>
<td>Operating Weight (LBS)</td>
<td></td>
</tr>
<tr>
<td>Total Air Flow (CFM)</td>
<td></td>
</tr>
<tr>
<td>System Supply Air Static Pressures (in. w.g.)</td>
<td></td>
</tr>
<tr>
<td>External Supply Ductwork</td>
<td></td>
</tr>
<tr>
<td>Discharge Loss</td>
<td></td>
</tr>
<tr>
<td>Cooling Coil</td>
<td></td>
</tr>
<tr>
<td>Clean Filters</td>
<td></td>
</tr>
<tr>
<td>Dirty Filter Allowance</td>
<td></td>
</tr>
<tr>
<td>Damper/Louver/Fitting Loss</td>
<td></td>
</tr>
<tr>
<td>Total Supply Fan Static</td>
<td></td>
</tr>
<tr>
<td>Systems Return Air Static Pressures (in. w.g.)</td>
<td></td>
</tr>
<tr>
<td>External Return Air Static Pressure</td>
<td></td>
</tr>
<tr>
<td>Entrance Loss</td>
<td></td>
</tr>
<tr>
<td>Internal Louver/Damper/Fitting Loss</td>
<td></td>
</tr>
<tr>
<td>Total Return Fan Static</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUPPLY FAN PERFORMANCE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Fan BHP</td>
<td></td>
</tr>
<tr>
<td>Supply Fan HP</td>
<td></td>
</tr>
<tr>
<td>Supply Fan RPM</td>
<td></td>
</tr>
<tr>
<td>Supply Fan Efficiency</td>
<td></td>
</tr>
<tr>
<td>Direct Drive Plenum Fans</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Fan Arrangement</td>
<td></td>
</tr>
<tr>
<td>Pressure Class</td>
<td></td>
</tr>
<tr>
<td>Aluminum Construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Bearings (L 10/200000 hours)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Fans selected at rated motor RPM</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RETURN FAN PERFORMANCE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Fan BHP</td>
<td></td>
</tr>
<tr>
<td>Return Fan HP</td>
<td></td>
</tr>
<tr>
<td>Return Fan RPM</td>
<td></td>
</tr>
<tr>
<td>Return Fan Efficiency</td>
<td></td>
</tr>
</tbody>
</table>
## CUSTOM FACTORY AIR HANDLING UNITS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Drive Plenum Fans</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Fan Arrangement</td>
<td></td>
</tr>
<tr>
<td>Pressure Class</td>
<td></td>
</tr>
<tr>
<td>Aluminum Construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Bearings (L 10/200000 hours)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Fans selected at rated motor RPM</td>
<td>Yes</td>
</tr>
</tbody>
</table>

## COIL PERFORMANCE

<table>
<thead>
<tr>
<th>Performance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Capacity (MBH)</td>
<td></td>
</tr>
<tr>
<td>Sensible Capacity (MBH)</td>
<td></td>
</tr>
<tr>
<td>Face Velocity (FPM)</td>
<td></td>
</tr>
<tr>
<td>GPM</td>
<td></td>
</tr>
<tr>
<td>Water Pressure Drop (ft. H2O)</td>
<td></td>
</tr>
<tr>
<td>Coils/Fins per Inch/Rows</td>
<td></td>
</tr>
<tr>
<td>Tube Size (inches)</td>
<td></td>
</tr>
<tr>
<td>Tube thickness (inches)</td>
<td></td>
</tr>
<tr>
<td>Tube return bend thickness</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Coils have 16 ga 304 SS</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Drain pans are 304 SS</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Coil blank offs are 304 SS</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>

## CABINET CONSTRUCTION

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Steel Channel base</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Tubular steel base</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Can vary base height</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Structural steel channel cross support</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Formed channel cross support</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Cross support max spacing</td>
<td></td>
</tr>
<tr>
<td>Thermal break at joints</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Outer steel (gauge)</td>
<td></td>
</tr>
<tr>
<td>Solid inner steel (gauge)</td>
<td></td>
</tr>
<tr>
<td>Insulation (wall/floor thickness) (inches)</td>
<td></td>
</tr>
<tr>
<td>Standing seam construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Welded frame construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Bolted construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Sheet metal screw construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Standing seam roof with seam cleats</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Roof attachment external to unit casing</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Outdoor-pitched roof</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Access door locations as required</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Double seals on doors</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Latches per door (number)</td>
<td></td>
</tr>
<tr>
<td>Adjustable door hinges</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Adjustable door latches</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Access doors open against static pressure</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Door safety “Kill” switches</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Polyurethane paint</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Vents and drains extended to outside cabinet</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Cabinet Sounds data for inlet &amp; outlet</td>
<td></td>
</tr>
<tr>
<td>Supply connection at 125 &amp; 1000 hz (db)</td>
<td></td>
</tr>
<tr>
<td>Return connection at 125 &amp; 1000 hz (db)</td>
<td></td>
</tr>
<tr>
<td>Economizer has min/max dampers</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>
## CUSTOM FACTORY AIR HANDLING UNITS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dampers sizing (maximum fpm)</td>
<td></td>
</tr>
<tr>
<td>Outside air louver sizing (maximum fpm)</td>
<td></td>
</tr>
<tr>
<td>Exhaust air louver sizing (maximum fpm)</td>
<td></td>
</tr>
<tr>
<td>Exterior hoods</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>

## ADDITIONAL UNIT FEATURES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine lights with GFI</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Fan screen enclosures</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Min OSA air flow station</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Airflow stations on each fan</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Motor removal rails</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Bellmouth outlet</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Roof curb</td>
<td>Yes or No</td>
</tr>
<tr>
<td>TEFC premium efficiency motors</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Shaft grounding factory mounted on motors</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Variable Frequency Drive (VFD) manufacturer</td>
<td></td>
</tr>
<tr>
<td>VFD’s are factory mounted &amp; wired (UL508)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Data sheets for VFD’s</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Filters are size and type specified</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Filter frames are face load type 8</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Two filter gages (one per filter bank)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Weather covers for filter gages</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Data sheets for filters</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Data sheets for air flow stations</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>

## PROVIDE DETAILS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base/floor construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Casing/cabinet construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Access doors</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Door hinges and latches</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Fan curves</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Pressure losses (including internal/external loss)</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Sound data for inlet/outlet</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Electrical wiring diagram</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Vibration isolation detail</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Coil construction</td>
<td>Yes or No</td>
</tr>
<tr>
<td>VFD mounting details</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>

## MANUFACTURER CAPABILITIES

<table>
<thead>
<tr>
<th>Feature</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Wheel Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Coil Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Dampers Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Louver Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Isolator Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Have a certified UL508 electrical shop</td>
<td>Yes or No</td>
</tr>
<tr>
<td>ARI certified for coils</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Coil Testing Capabilities</td>
<td>Yes or No</td>
</tr>
<tr>
<td>AMCA certified for blowers</td>
<td>Yes or No</td>
</tr>
<tr>
<td>UL-508</td>
<td>Yes or No</td>
</tr>
</tbody>
</table>
### CUSTOM FACTORY AIR HANDLING UNITS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Yes or No</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMCA 210 accredited lab</td>
<td></td>
</tr>
<tr>
<td>AMCA 300 accredited lab</td>
<td></td>
</tr>
<tr>
<td>Ability to perform leak tests</td>
<td></td>
</tr>
<tr>
<td>UL-508 compliance</td>
<td></td>
</tr>
<tr>
<td>Unit ETL or UL listing</td>
<td></td>
</tr>
</tbody>
</table>

END OF SECTION
PACKAGED HVAC UNITS

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Packaged unit
   2. Controls and control connections
   3. Electrical power connections
   4. Roof mounting frame and base

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Section 233113: Air Distribution
F. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 Standards Handbook
      b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
      c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
      d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
      e. 500 Test Method for Louvers, Dampers, and Shutters
      a. 9 Load Ratings and Fatigue Life for Ball Bearings
      b. 11 Load Ratings and Fatigue Life for Roller Bearings
      c. 900 Test Performance of Air Filter Units
   3. Air-Conditioning and Refrigeration Institute (ARI):
      a. 210 Unitary Air Conditioning Equipment
      b. 270 Sound Rating of Outdoor Unitary Equipment
   4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. 15 Safety Code for Mechanical Refrigeration
   5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
   6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
      a. 70 National electrical Code
PACKAGED HVAC UNITS

b. 90A  Standard for the Installation of Air Conditioning and Ventilating Systems

c. 90B  Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors’ National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.

1.5 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
1. The proposed substitution does not affect dimensions shown on drawings.
2. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
3. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
4. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for packaged units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 1.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.9 WARRANTY

A. Provide general one year (12 months) warranty with five (5) year warranty on compressors. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP HEATING/COOLING UNIT (GAS/ELECTRIC 3 TO 6 TONS)

A. General:
PACKAGED HVAC UNITS

1. Outdoor rooftop mounted, electrically controlled heating and cooling unit utilizing a reciprocating compressor for cooling duty and gas combustion for heating duty. Unit shall discharge supply air downward or horizontally as shown on contract drawings.

2. Unit shall be rated in accordance with ARI Standards 210240 and 270. Designed in accordance with UL Standard 465.

3. Unit shall be designed to conform to ANSI/ASHRAE 15.

4. Unit shall be UL tested and certified in accordance with ANSI Z21.47 Standards and CSA or CGA certified as a total package.

5. Roof curb shall be designed to conform to NRCA Standards.

6. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

B. Equipment (Standard):

1. General:
   a. Factory assembled, single piece heating and cooling unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410A) and special features required prior to field start-up.

2. Unit Cabinet:
   a. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a prepainted baked enamel finish on all externally exposed surfaces.
   b. Indoor blower compartment interior cabinet surfaces shall be insulated with a minimum 1/2" thick, flexible glass fiber insulation, coated on the air side. Aluminum foil faced glass fiber insulation shall be used in the furnace compartment.
   c. Cabinet panels shall be easily removable for servicing.
   d. Filters will be accessible through a hinged access door, and will require no panel or screw removal.
   e. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
   f. Unit shall have a factory installed internal condensate drain trap made of a non-corrosive material, providing a minimum 3/4" connection.

3. Fans:
   a. Indoor blower (evaporator fan):
      1) Fan shall be direct or belt driven as shown on the equipment drawings. Belt drive shall include an adjustable pitch motor pulley.
      2) Fan wheel shall be double inlet type with forward curved blades.
      3) Bearings shall be sealed, permanently lubricated ball bearing type for longer life and lower maintenance.
   b. Indoor blower shall be made from steel with a corrosion resistant finish and shall be dynamically balanced.
   c. Outdoor (condenser) fan shall be of the direct driven propeller type and shall discharge air vertically upward.
   d. Outdoor fan shall have aluminum blades riveted to corrosion resistant steel spiders and dynamically balanced.
   e. Induced draft blower shall be of the direct driven, single inlet, forward curved centrifugal type, made from steel with a corrosion resistant finish and dynamically balanced.

4. Compressor:
   a. Fully hermetic type, internally protected.
   b. Factory rubber shock mounted and internally spring mounted for vibration isolation.
   c. Equipped with a factory installed crankcase heater to minimize liquid refrigerant accumulation in compressor during shutdown and prevent refrigerant dilution of oil.

5. Coils:
   a. Evaporator and condenser coils shall have aluminum plate fins mechanically bonded to seamless copper tubes with all joints brazed.
   b. Tube sheet openings shall be belled to prevent tube wear.
   c. Evaporator coil shall be of the full-face active design, degreased at the factory.
6. Heating Section:
   a. Induced draft combustion type with energy saving direct spark ignition system and redundant main gas valve.
   b. The heat exchanger shall be of the tubular section type constructed of a minimum of 20-gauge steel coated with a nominal 1.2 mil aluminum silicone alloy for corrosion resistance.
   c. Burners shall be of the in-shot type constructed of aluminum coated steel.
   d. All gas piping shall enter the unit cabinet at a single location.

7. Refrigerant Components: Refrigerant circuit components shall include:
   a. Acutrol feed system.
   b. Filter drier.
   c. Service gauge connections on suction, discharge and liquid lines.

8. Filter Section:
   a. Standard filter section shall consist of factory installed low velocity, disposable 2" thick glass fiber filters of commercially available sizes.
   b. Filter face velocity shall not exceed 320 fpm at nominal airflows.
   c. Filter section should use only one size filter.

9. Controls and Safeties:
   a. Unit Controls: Unit shall be complete with self-contained low voltage control circuit protected by a manually resettable circuit breaker.
   b. Safeties:
      1) Unit shall incorporate a solid state compressor protector which provides reset capability at the space thermostat, should any of the following standard safety devices trip and shut off compressor:
         a) Compressor over temperature, overcurrent.
         b) Loss of charge/low pressure switch.
         c) Freezestat, evaporator coil.
         d) High-pressure switch.
      2) Heating section shall be provided with the following minimum protections:
         a) High temperature limit switch.
         b) Induced draft motor centrifugal switch.
         c) Flame rollout switch (manual reset).
         d) Flame proving controls.

10. Operating Characteristics:
    a. Unit shall be capable of starting and running at 115° F ambient outdoor temperature per maximum load criteria of ARI Standard 210/240.
    b. Compressor with standard controls shall be capable of operation down to 25° F ambient outdoor temperature.
    c. Unit provided with fan time delay of 55 seconds to prevent cold air delivery before heat exchanger warms up.

11. Electrical Requirements: All unit power wiring shall enter unit cabinet at a single factory predrilled location.

12. Motors:
    a. Compressor motors shall be cooled by suction gas passing through motor windings and shall have line break thermal and current overload protection.
    b. Indoor blower motor shall have permanently lubricated bearings and inherent automatic reset thermal overload protection.
    c. Outdoor totally enclosed motor shall have permanently lubricated bearings, and inherent automatic reset thermal overload protection.
    d. Induced draft motor shall have permanently lubricated sealed bearings and inherent automatic reset thermal overload protection.

C. Special Features and Options:
1. Provide the following options with units. (Certain features are not applicable when the features designated * are specified. For assistance in amending the specifications, your local Carrier Sales Office should be contacted.)
PACKAGED HVAC UNITS

a. Roof Curb:
   1) Formed galvanized steel with wood nailer strip and capable of supporting entire unit weight.

b. Integrated Economizer:
   1) Integrated type capable of simultaneous economizer and compressor operation.
   2) Includes all hardware and controls to provide cooling with outside air.
   3) Equipped with a single sliding plate low leakage type damper.
   4) Capable of introducing up to 100% outside air.
   5) Equipped with a gravity relief damper.

c. Manual Damper:
   1) Manual damper package shall consist of damper, bird screen and rain hood which can be preset to admit up to 50% outdoor air for year round ventilation.

d. Two Position Damper:
   1) Two-position damper package shall include single blade damper and motor. Admits up to 50% outdoor air.
   2) Damper shall close upon indoor fan shutoff.

e. Optional Compressor Cycle Delay:
   1) Compressor shall be prevented from restarting for a minimum of 5 minutes after shutdown.

f. Solid State Enthalpy Control:
   1) For use with economizer package only.
   2) Capable of sensing outdoor air heat content (temperature and humidity) and control economizer cut-in point to have minimum heat content air passing over the evaporator coil for most efficient system operation.

g. Differential Enthalpy Sensor:
   1) For use with economizer only.
   2) Capable of comparing heat content (temperature and humidity) of outdoor air and return air and controlling economizer cut-in point at the most economical level.

h. Head Pressure Control Package:
   1) Consists of solid-state control and condenser coil temperature sensor to maintain condensing temperature between 90° F and 110° F at outdoor ambient temperatures down to -20° F by either condenser fan speed modulation or condenser fan cycling.

i. Remote Control Panel: Panel shall be a decorative, indoor, wall mounted panel consisting of:
   1) Two stage heat/two stage cool thermostat.
   2) Automatic changeover.
   3) System switch with HEAT - COOL - AUTO - OFF settings.
   4) Fan switch with ON - AUTO settings.
   5) Indicator lights for HEAT - COOL - FAN operation.
   6) Three unused indicator lights for field use.

j. LP Gas Kit:
   1) Package shall contain all the necessary hardware and instructions to convert a standard natural gas unit for use with liquefied propane gas.

k. Electronic Programmable Thermostat:
   1) Capable of using deluxe full featured electronic thermostat.

l. Thermostat and Subbase:
   1) Provides staged cooling and heating automatic (or manual) changeover, fan control and indicator light.

D. Manufacturer: Carrier Model (48DJD)(48DJE) or approved equal by Trane, McQuay or Lennox.

2.2 PACKAGED ROOFTOP HEATING/CoolING UNIT (GAS/ELECTRIC 7-1/2 TO 12-1/2 TONS)
A. General:
1. Outdoor rooftop mounted, electrically controlled heating and cooling unit utilizing a reciprocating compressor for cooling duty and gas combustion for heating duty. Unit shall discharge supply air downward or horizontally as shown on contract drawings.
2. Unit shall be rated in accordance with ARI Standards 210/240 or 360 and 270. Designed in accordance with UL Standard 465.
3. Unit shall be designed to conform to ANSI/ASHRAE 15-1978.
4. Unit shall be UL tested and certified in accordance with ANSI Z21.47 Standards and CSA certified as a total package.
5. Roof curb shall be designed to conform to NRCA Standards.
6. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

B. Equipment (Standard):
1. General:
   a. Factory assembled, single piece heating and cooling unit. contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410A) and special features required prior to field start-up.
2. Unit Cabinet:
   a. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a prepainted baked enamel finish on all externally exposed surfaces.
   b. Indoor blower compartment interior cabinet surfaces shall be insulated with a minimum 1/2" thick, flexible glass fiber insulation, coated on the air side. Aluminum foil faced glass fiber insulation shall be used in the furnace compartment.
   c. Cabinet panels shall be easily removable for servicing.
   d. Filters will be accessible through a hinged access door, and will require no panel or screw removal.
   e. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
   f. Unit shall have a factory installed internally trapped condensate drain made of a non-corrosive material, providing a minimum 3/4" connection.
3. Fans:
   a. Indoor blower (evaporator fan):
      1) Fan shall be belt driven as shown on the equipment drawings. Belt drive shall include an adjustable pitch motor pulley.
      2) Fan wheel shall be double inlet type with forward curved blades.
      3) Bearings shall be sealed, permanently lubricated ball bearing type for longer life and lower maintenance.
   b. Indoor blower shall be made from steel with a corrosion resistant finish and shall be dynamically balanced.
   c. Outdoor (condenser) fan shall be of the direct driven propeller type and shall discharge air vertically upward.
   d. Outdoor fan shall have aluminum blades riveted to corrosion resistant steel spiders and shall be dynamically balanced.
   e. Induced draft blower shall be of the direct driven single inlet forward curved centrifugal type, made from steel with a corrosion resistant finish and dynamically balanced.
4. Compressor:
   a. Fully hermetic type, on independent circuits and internally protected.
   b. Factory rubber shock mounted and internally spring mounted for vibration isolation.
   c. Equipped with a factory installed crankcase heater to minimize liquid refrigerant accumulation in compressor during shutdown and prevent refrigerant dilution of oil.
5. Coils:
   a. Evaporator and condenser coils shall have aluminum plate fins mechanically bonded to seamless copper tubes with all joints brazed and degreased at the factory.
PACKAGED HVAC UNITS

b. Tube sheet openings shall be belled to prevent tube wear.

6. Heating Section:
   a. Induced draft combustion type with energy saving direct spark ignition system and redundant main gas valve.
   b. The heat exchanger shall be of the tubular section type constructed of a minimum of 20-gauge steel coated with a nominal 1.2 mil aluminum silicone alloy for corrosion resistance.
   c. Burners shall be of the in-shot type constructed of aluminum coated steel.
   d. All gas piping shall enter the unit cabinet at a single location.

7. Refrigerant Components:
   a. Refrigerant circuit components shall include:
      1) Acutrol feed system.
      2) Filter drier.
      3) Service gauge connections on suction, discharge and liquid lines.

8. Filter Section:
   a. Standard filter section shall consist of factory installed low velocity, disposable 2" thick glass fiber filters of commercially available sizes.
   b. Filter face velocity shall not exceed 320 fpm at nominal airflows.

9. Controls and Safeties:
   a. Unit Controls:
      1) Unit shall be complete with self-contained low voltage control circuit protected by a manually resettable circuit breaker.
   b. Safeties:
      1) Unit shall incorporate a solid state compressor protector which provides reset capability at the space thermostat, should any of the following safety devices trip and shut off compressor:
         a) Compressor overtemperature, overcurrent.
         b) Loss of charge/low pressure switch.
         c) Freezeast, evaporator coil.
         d) High-pressure switch.
      2) Heating section shall be provided with the following minimum protections:
         a) High temperature limit switch.
         b) Induced draft motor centrifugal switch.
         c) Flame rollout switch (manual reset).
         d) Flame proving controls.

10. Operating Characteristics:
    a. Unit shall be capable of starting and running at 115° F ambient outdoor temperature per maximum load criteria of ARI Standard 210/240 or 360.
    b. Compressor with standard controls shall be capable of operation down to 25° F ambient outdoor temperature.
    c. Unit provided with fan time delay of 55 seconds to prevent cold air delivery before heat exchanger warms up.

11. Electrical Requirements:
    a. All unit power wiring shall enter unit cabinet at a single factory predrilled location.

12. Motors:
    a. Compressor motors shall be cooled by suction gas passing through motor windings and shall have line break thermal and current overload protection.
    b. Indoor blower motor shall have permanently lubricated bearings and inherent automatic reset thermal overload protection.
    c. Outdoor totally enclosed motor shall have permanently lubricated bearings, and inherent automatic reset thermal overload protection.
    d. Induced draft motor shall have permanently lubricated sealed bearings and inherent automatic reset thermal overload protection.

C. Special Features and Options:
PACKAGED HVAC UNITS

1. Provide the following options with units. (Certain features are not applicable when the features designated * are specified. For assistance in amending the specifications, your local Carrier Sales Office should be contacted.)
   a. Roof Curb:
      1) Formed galvanized steel with wood nailer strip and capable of supporting entire unit weight.
   b. Integrated Economizer:
      1) Integrated type capable of simultaneous economizer and compressor operation.
      2) Includes all hardware and controls to provide cooling with outside air.
      3) Equipped with low leakage dampers not to exceed 3% leakage, at 1.0” wg pressure differential.
      4) Capable of introducing up to 100% outside air.
      5) Equipped with a gravity relief damper.
   c. Manual Damper: Manual damper package shall consist of damper, bird screen and rain hood which can be preset to admit up to 50% outdoor air for year round ventilation.
   d. Two Position Damper:
      1) Two-position damper package shall include single blade damper and motor. Admits up to 100% outdoor air.
      2) Damper shall close upon indoor fan shutoff.
   e. Optional Compressor Cycle Delay: Compressor shall be prevented from restarting for a minimum of 5 minutes after shutdown.
   f. Solid State Enthalpy Control:
      1) For use with economizer package only.
      2) Capable of sensing outdoor air heat content (temperature and humidity) and control economizer cut-in point to have minimum heat content air passing over the evaporator coil for most efficient system operation.
   g. Differential Enthalpy Sensor:
      1) For use with economizer only.
      2) Capable of comparing heat content (temperature and humidity) of outdoor air and return air and controlling economizer cut-in point at the most economical level.
   h. Head Pressure Control Package:
      1) Consists of solid-state control and condenser temperature sensor for head pressure control.
      2) Capable of controlling outdoor fan motor cycling to maintain condensing temperature between 90° F and 110° F at outdoor ambient temperatures down to -20° F.
   i. Remote Control Panel: Penal shall be a decorative, indoor, wall mounted panel consisting of:
      1) Two stage heat/two stage cool thermostat.
      2) Automatic changeover.
      3) System switch with HEAT - COOL - AUTO - OFF settings.
      4) Fan switch with ON - AUTO settings.
      5) Indicator lights for HEAT - COOL - FAN operation.
      6) Three unused indicator lights for field use.
   j. LP Gas Kit: Package shall contain all the necessary hardware and instructions to convert a standard natural gas unit for use with liquefied propane gas.
   k. Electronic Programmable Thermostat: Capable of using deluxe full featured electronic thermostat.
   l. Thermostat and Subbase: Provides staged cooling and heating automatic (or manual) changeover, fan control and indicator light.

D. Manufacturer: Carrier Model (48DJD)(48DJE) or approved equal by Trane, McQuay or Lennox.

2.3 SPRING ISOLATING ROOF CURB
PACKAGED HVAC UNITS

A. Curb mounted rooftop packaged air conditioning air handlers shall be flexibly ducted, provided with double arch EPDM Expansion Joints, and electrical lines with flexible conduits. The units shall be supported by a spring isolation curb, the lower member of which is a rigid steel tube or a specially formed steel section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must remain captive when resiliently resisting wind and seismic forces. All directional neoprene snubber bushings must be a minimum of 1/2" thick. Steel springs shall rest on 1/4" neoprene acoustical pads. Minimum spring deflection shall be 1 1/2". Hardware must be cadmium or zinc electroplated and the springs similarly plated or provided with an approved rust resistant finish.

B. The curb’s waterproofing shall consist of a continuous galvanized flexible counterflashing nailed over the lower curb’s waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers.

C. The floating member of the roof curb shall have perimeter angle and cross members to support two layers of 5/8" waterproof sheetrock laid on with staggered joints. Sheetrock must surround ducts to provide a continuous sound break. This acoustical barrier shall be caulked to minimize sound transmission. Where the mechanical arrangement makes attachment to the floating member unfeasible, the barrier shall be attached at the highest practical elevation of the fixed curb with provision for 1" thick closed cell neoprene flexible seals around the ductwork. A four inch layer of 1.5 density fiberglass shall cover the entire solid roof surface under the unit. Ductwork shall be lined with sound absorbent material.

D. Curbs shall be Mason Industries Type RSC-dB or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting surface, e.g. roof, is ready to receive work.
B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Provide layout drawings of units, locations and power requirements to electrical installer.
C. Install minimum 30% efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.
D. Mount rooftop unit on factory built roof mounting frame. Install roof mounting frame level.
E. Install 3” flexible duct connection at inlets and outlets of units.
F. Install condensate drain piping and traps in accordance with manufacturer’s instructions and as shown on the Drawings.
G. Control installers shall install thermostat and all wiring associated with control signals into the units.
H. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
I. Install a new set of filters prior to final air balance and substantial completion.

3.3 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.
PACKAGED HVAC UNITS
END OF SECTION
MINI-SPLIT AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Split air conditioning unit.
   2. Controls and control connections.
   3. Electrical power connections.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Section 232123: Pumps and Hydronic Specialties
F. Section 232300: Refrigerant Piping Systems
G. Section 233113: Air Distribution
H. Division 26: Electrical

1.4 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99 Standards Handbook
      b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
   2. Air-Conditioning and Refrigeration Institute (ARI):
      a. 210 Unitary Air-Conditioning Equipment
      b. 270 Sound Rating of Outdoor Unitary Equipment
   3. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
   4. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
      a. 70 National Electrical Code
      b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
      c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems
   5. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
   6. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL.
MINI-SPLIT AIR CONDITIONING UNITS

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals; in accordance with requirements of Division 01.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store/protect products under provisions of Division 01. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

1.8 WARRANTY

A. Provide general one year (12 months) warranty from date of installation and five (5) year warranty on compressors under provisions of Division 01. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNIT WITH INDOOR FAN COIL

A. Acceptable Manufacturers: Mitsubishi, Sanyo, or approved equal.

B. Indoor Fan Coil Unit

1. General:
   a. Factory fabricated fan coil units of the size, type configuration and capacity as scheduled on the drawings. Units shall be self-contained, factory assembled and pre-wired with condensate pump.
   b. All pressure drops, horsepowers and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
   c. Manufacturers unable to meet this criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name do not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.

2. Unit cabinet shall be galvanized steel with powder coated baked enamel finish.

3. Fan Assembly
   a. Direct-drive, double-inlet fan wheels shall have forward-curved blades, and be statically and dynamically balanced, with scrolls and fans constructed of galvanized steel.
   b. Rotating assembly shall provide a rigid support for motor and fan assembly. Assembly shall be accessible and entire assembly shall be removable for maintenance.
   c. Motor shall be minimum two speed permanent split capacitor type.
MINI-SPLIT AIR CONDITIONING UNITS

4. Coils shall be ARI certified. All coil shall constructed of non-ferrous seamless copper and pressure tested in the factory.

5. Filter shall be one inch thick pleated.

6. Unit Suspension: Units shall be provided with factory welded mounting clips for mounting of units.

7. Electrical: The unit electrical power shall be 115 volts, 1 phase, 60 hertz.

8. Controls
   a. Unit shall have a wired controller to perform input functions necessary to operate the system.
   b. The controller shall consist of an On-Off switch, Cool/Dry-Fan selector, Thermostat setting, Timer Mode, High-Low fan speed, Auto Vane selector, Test Run switching and Check Mode switching.
   c. Temperature changes shall be by 2°F increments with a range of 65 - 87°F.
   d. The control system shall consist of two (2) microprocessors interconnected by a single non-polar two wire cable.
   e. Wiring shall run direct from the indoor unit to the controller with no splices.
   f. Manufacturer shall provide 2 conductor 18 Ga. stranded wire for connection to remote controller.
   g. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.
   h. Normal operation of the remote controller provides individual system control in which one remote controller and one indoor unit are installed in the same room.
   i. The control voltage from the controller to the indoor unit shall be 12 volts, DC.
   j. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.
   k. The system shall be capable of automatic restart when power is restored after power interruption.
   l. The system shall include self-diagnostics including total hours of compressor run time.
   m. The microprocessor within the wall mounted remote controller shall provide automatic cooling, display set point and room temperature, 24 hour on/off timer so that automatic operation function display, check mode for memory of most recent problem.

C. Outdoor Condensing Unit:
   1. General: Provide remote outdoor compressor units consisting of hermetic compressor with overload protection, direct drive condenser fan, aluminum fin/seamless copper tube coil, strainer, high and low pressure switches, accumulator, and thermostatic expansion valve.
   2. Low Ambient Control: System shall be capable of operating at 0°F ambient temperature.
   3. Unit Cabinet: Galvanized steel with powder coat enamel finish.
   4. Condenser Fans: Direct drive propeller type. Motors to be totally enclosed, single phase, with Class B insulation and permanently lubricated bearings. Fan shall be mounted for low noise. Fan blades to be statically and dynamically balanced.
   5. Coil: Aluminum fins mechanically bonded to copper tubes.
   7. Compressor: Hermetically sealed two-speed compressor mounted on rubber mountings. Protection to include internal thermal overloads. An internal pressure relief valve to provide high-pressure protection to the refrigerant system. Provide external service valves for the refrigerant circuit. A crankcase heater shall be factory mounted on the outside of the compressor.
MINI-SPLIT AIR CONDITIONING UNITS

8. Electrical: Unit electrical power shall be 208/230 volts, 1 phase, 60 hertz. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control voltage between the indoor unit and the outdoor unit shall be 12 volts, DC.

PART 3 - PRODUCTS

3.1 EXAMINATION
   A. Verify that mounting surfaces are ready to receive work.
   B. Verify that proper power supply is available.

3.2 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Provide layout drawings of units, locations and power requirements to electrical installer.
   C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.
   D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.
   E. Provide 4" high concrete pad extending 6" beyond edge of condensing unit on all sides. Attach condensing unit to concrete pad with concrete anchors and angle brackets.
   F. Install condensate drain piping and traps in accordance with manufacturer's instructions and as shown on the Drawings.
   G. Install copper refrigerant piping and insulate lines.
   H. Install controller and all wiring associated with control signals between air handling unit and condensing unit. Conceal low voltage wiring in building structure, or inside the refrigerant pipe insulation, or in conduit.
   I. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
   J. Install a new set of filters prior to final air balance and substantial completion.

3.3 MANUFACTURER'S START-UP SERVICES
   A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Condensing Units
      a. Air Cooled Condensing Unit – Heat Pump (heat or cool model)
      b. Air Cooled Condensing Unit – Heat Recovery (heat and cool model)
   2. Branch Selector (BS) Units or Branch Circuit (BC) Terminal for Heat Recovery systems.
   3. Indoor Fan Coil Units:
      a. Non-ducted Recessed Ceiling Cassette Units
      b. Ducted Concealed Ceiling Fan Coil Units
         1) Ceiling Suspended Unit
         2) Wall Mounted Unit
         3) Floor Console Unit
         4) Floor Console Concealed Unit
      c. Vertical/horizontal Air handling Unit
      d. 100% OSA Makeup Air Units – 100% OSA Processing Unit
   4. Controls
   5. Refrigerant gas monitors

1.3 SYSTEM DESCRIPTION (CHOOSE HEAT PUMP OR HEAT RECOVERY)
A. Heat Pump (heat or cool model)
   1. The variable capacity heat pump air conditioning system shall be a VRV/VRF series heat or cool model. The system shall consist of multiple evaporators, heat pump condensing unit with variable speed inverter driven compressors, and PID DDC (direct digital controls). All zones are each capable of operating separately with individual temperature control.
   2. Operation of the system shall permit either cooling or heating of all of the indoor units simultaneously. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.

B. Heat Recovery (heat and cool model)
   1. The variable capacity heat pump air conditioning system shall be a VRV/VRF series heat and cool model. The system shall consist of multiple evaporators, Branch Selector Units or Branch Circuit Terminals, heat recovery condensing unit with variable speed inverter driven compressors, and PID DDC (direct digital controls). All zones are each capable of operating separately with individual temperature control.
   2. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with each branch of the cool/heat selector box. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager or a BMS interface.

1.4 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: HVAC Insulation
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

D. Section 232300: Refrigerant Piping Systems
E. Section 233113: Air Distribution
F. Division 26: Electrical

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide packaged units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:

1. Air Movement and Control Association (AMCA):
   a. 99 Standards Handbook
   b. 210 Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
   c. 300 Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
   d. 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data
   e. 500 Test Method for Louvers, Dampers, and Shutters

   a. 9 Load Ratings and Fatigue Life for Ball Bearings
   b. 11 Load Ratings and Fatigue Life for Roller Bearings
   c. 900 Test Performance of Air Filter Units

   a. 1230 Variable Refrigerant Flow Multi-split Air –conditioners and Heat Pumps

4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 15 Safety Code for Mechanical Refrigeration

5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.

6. National Fire Protection Association (NFPA): Provide unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:
   a. 70 National electrical Code
   b. 90A Standard for the Installation of Air Conditioning and Ventilating Systems
   c. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of units, which have been listed and labeled by UL. This includes condensate pumps and other ancillary devices required for operation.

9. Electrical Laboratories (ETL): The units shall be listed by ETL and bear the ETL label.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for systems with air handler units, evaporator coils, and outdoor condensing units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data,
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:
A. Daikin VRV III, Mitsubishi City Multi, or LG-Multi V.

2.2 CONDENSING UNIT
A. General:
1. The outdoor unit shall be designed for used with an integrated variable refrigerant flow zone system.
2. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
3. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
4. (Heat Recovery Only) Refrigerant lines from the outdoor unit to the BS or BC unit shall be individually insulated between the condensing and fan coil units.
5. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
6. The connection ratio of fan coil units to condensing unit shall be permitted up to 150% of outdoor rated capacity.
7. Each condensing system shall be able to support the connection of up to 50 indoor units dependent on the model of the condensing unit.
8. The sound pressure level standard shall no greater than 65 dBA at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time.
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

9. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

10. Water-cooled only:
   a. Each condensing unit shall have a 240VAC, 0.3mA-0.5A control circuit output for water pump or isolation valve operation. This circuit shall be configured at commissioning to operate based on system or compressor operation.
   b. Each condensing unit shall incorporate normally open, 15VDC and 1.0mA rated contacts for integration of a mandatory flow proving device.

11. The unit shall incorporate an auto-charging feature.

12. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

13. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

14. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.

15. Each system shall maintain continuous heating during oil return operation.

16. The condensing unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.

17. (Heat Recovery only) The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

B. Unit Cabinet:
   1. Air Cooled: The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
   2. Water Cooled: The condensing unit shall be corrosion resistant. The unit shall be constructed from rust-proofed, mild steel panels coated with a baked enamel finish.

C. Fan (air-cooled models only):
   1. The condensing unit shall consist of one or more propeller type, direct-drive fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
   2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.24 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
   3. The fan shall be a vertical discharge configuration.
   4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
   5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
   6. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature.

D. Condenser Coil (air-cooled):
   1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
   2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
   3. The fins are to be covered with an anti-corrosion finish.

E. Condenser Heat Exchanger (water-cooled):
   1. The condenser heat exchanger shall be a stainless brazed plate type designed for closed loop/dry cooler applications.
   2. The heat exchanger shall have a maximum system water pressure of 285 psi (equivalent to 640ft of head).
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

F. Compressor:
1. The inverter driven scroll hermetic compressors shall be variable speed controlled capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.
2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll type.
3. The capacity control range shall be as low as 4% to 100%.
4. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
5. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
6. Oil separators shall be standard in the equipment together with an intelligent oil management system.
7. The compressor shall be spring mounted to avoid the transmission of vibration.

G. Electrical:
1. The power supply to the condensing unit shall be 460 (208/230) volts, 3 phase, 60 hertz +/- 10%.
2. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.

2.3 BRANCH SELECTOR (BS) BOX/ BRANCH CIRCUIT (BC) CONTROLLER FOR HEAT RECOVERY SYSTEM

A. General: Branch selector boxes/ Branch circuit controllers are designed specifically for use with heat recovery system components.
1. Selector boxes / circuit controllers shall be factory assembled, wired, piped and run tested at the factory.
2. Selector boxes / circuit controllers must be mounted indoors.
3. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling electronic expansion valve.

B. Unit Cabinet:
1. These units shall have a galvanized steel plate casing.
2. Each cabinet shall house multiple electronic expansion valves for refrigerant control per branch.
3. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

C. Refrigerant Valves:
1. The refrigerant connections must be of the braze type.
2. Multiple indoor units may be connected to a branch selector box / branch circuit controller.

D. Condensate Removal:
1. Provide integral condensate pan if required for condensate removal.

E. Electrical:
1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
2. The unit shall be capable of operation within the limits of 187 volts to 228 volts.
3. The minimum circuit amps (MCA) shall be 0.1 and the maximum
4. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded 2 conductor cable.

2.4 INDOOR FAN COIL UNITS
A. Non-Ducted Recessed Ceiling Cassette Units

1. General: Indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, white, impact resistant with a washable decoration panel. The supply air is distributed via motorized louver which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The indoor units sound pressure shall range from 28 dB(A) to 34 dB(A) at low speed measured at 5 feet below the unit.

2. Indoor Unit:
   a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
   b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
   c. Both refrigerant lines shall be insulated from the outdoor unit.
   d. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
   e. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
   f. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built in safety shutoff and alarm.
   g. The indoor units shall be equipped with a return air thermistor.

3. Unit Cabinet:
   a. The cabinet shall be space saving and shall be located into the ceiling.
   b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
   c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
   d. Fresh air intake shall be possible by way of optional fresh air intake kit. (3’x 3’ model only). Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet. (2’x 2 model only’)
   e. A branch duct knockout shall exist for branch ducting supply air.
   f. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
   g. Optional high efficiency MERV 8 and 13 air filters are available for each model unit. (3’x 3’ model only)

4. Fan:
   a. The fan shall be direct-drive fan type with statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
   c. The airflow rate shall be available in high and low settings.
   d. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with the MERV 8 and 13 filter options (3’x 3’ model only).
   e. The fan motor shall be thermally protected.

5. Filter:
   a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
   b. Optional high efficiency disposable MERV 8 and 13 filters shall be available. (3’x 3’ model only)
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

6. Coil:
   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   c. The coil shall be a 2-row cross fin copper evaporator coil completely factory tested.
   d. The refrigerant connections shall be flare connections.
   e. A condensate pan shall be located under the coil.
   f. A condensate pump up to 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
   g. A thermistor will be located on the liquid and gas line.

7. Electrical:
   a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

8. Control:
   a. The unit shall have on board controls to perform input functions necessary to operate the system.
   b. The unit shall include all devices necessary to be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.

9. Optional Accessories Available:
   a. A high efficiency disposable MERV 8 air filter kit. (3’ x 3’)
   b. A high efficiency disposable MERV 13 air filter kit. (3’ x 3’)
   c. Fresh air intake kit.
   d. Supply air branch duct connections.
   e. Remote “in-room” sensor kit.
   f. The wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

B. Ducted Concealed Ceiling Fan Coil Units

1. General:
   a. Indoor unit shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation in a ceiling cavity. It is constructed of a galvanized steel casing. It shall be a horizontal discharge air with horizontal return air configuration. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. Included as standard equipment, a condensate drain pan and drain pump kit that pumps up to 18-3/8” from the drain pipe opening.
   b. All pressure drops, horsepowers and dimensions shown on drawing schedules are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.
   c. Manufacturers unable to meet this criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturers listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.

2. Sound Pressure Level:
   a. Large capacity, medium static units: 48 dB(A) at low speed measured 5 feet below the ducted unit.
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

b. Small capacity, medium static units: 29 dB(A) to 40 dB(A) at low speed measured 5 feet below the ducted unit.

c. Shallow depth fan coils: 29 dB(A) to 32 dB(A) at low speed and 33 dB(A) to 36 dB(A) at high speed 5 feet below the suction grille.

3. Indoor Unit: The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch (Large models). The unit shall be equipped with automatically adjusting external static pressure logic selectable during commissioning. This adjusts the airflow based on the installed external static pressure. (Small models)

a. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

b. Both refrigerant lines shall be insulated from the outdoor unit.

c. The indoor units shall be equipped with a return air thermistor.

d. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 18-3/8" of lift from the center of the drain outlet (Small and slim model only)

e. Return air shall be through a resin net mold resistant filter (slim model only)

4. Unit Cabinet:

a. The cabinet shall be located within the ceiling and ducted to the supply and return openings.

b. The cabinet shall be constructed with minimum ½" 1.5 lb internal insulation. Insulation shall be attached with adhesive with all exposed edges coated to prevent erosion or of an insulation type not requiring protection.

5. Fan:

a. (Large models and slim duct):
   1) The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
   2) The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz, with a motor output of 0.51 HP.
   3) The airflow rate shall be available in high and low settings.
   4) The fan motor shall be thermally protected.
   5) The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

b. Fan (Small models):
   1) The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
   2) The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning.
   3) The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
   4) The airflow rate shall be available in three settings.
   5) The fan motor shall be thermally protected.
   6) The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.

6. Coil:

a. Coils shall be ARI certified of the direct expansion type.

b. All coil casings shall be galvanized steel minimum or stainless steel.

c. Copper tubes shall be a minimum thickness of 0.020 and return bends of minimum 0.035. Headers shall be non-ferrous seamless copper. Aluminum fins shall have a minimum thickness of 0.0080 and tubes shall be mechanically expanded into fin collars to provide permanent mechanical bond.

d. The coils shall be pressure tested at the factory.

e. The refrigerant connections shall be flare connections.

f. A thermistor will be located on the liquid and gas line.
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

- **A condensate pan shall be located under the coil**
- **The condensate shall be capable of being gravity drained from the fan coil.**
- **Where scheduled, a condensate pump with an 18” minimum lift shall be located below the coil in the condensate pan with a built-in safety alarm.**

7. **Electrical:**
   - **A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.**
   - **Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).**
   - **Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.**

8. **Control:**
   - **The unit shall have on board controls to perform input functions necessary to operate the system.**
   - **The unit shall include all devices necessary to be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.**

9. **Optional Accessories Available:**
   - **Remote “in-room” sensor kit (recommended).**
   - **The wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature. The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).**

C. **Non-Ducted Wall or Ceiling Fan Coil Units**

1. **General:** **Indoor unit shall be a fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall or ceiling within a conditioned space. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition.**

2. **Condensate drain pan:**
   - **Ceiling Suspended Cassette Unit:** **A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment.**
   - **Wall Mounted Unit:** **A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment.**
   - **Floor Console Unit:** **A mold-resistant, resin net air filter shall be included as standard equipment.**

3. **Sound Pressure:**
   - **Ceiling Suspended Cassette Unit:** The indoor units sound pressure shall range from 32 dB(A) to 38 dB(A) at low speed measured at 3.3 feet below and from the unit.
   - **Wall Mounted Unit:** The indoor units sound pressure shall range from 31 dB(A) to 40 dB(A) at low speed measured at 3.3 feet below and from the unit.
   - **Floor Console Units (Surface mount and concealed types):** The indoor units sound pressure shall range from 35 dB(A) to 40 dB(A) at high speed measured at 5 feet away and 5 feet high.

4. **Indoor Unit:**
   - **The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops**
   - **Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.**
   - **Both refrigerant lines shall be insulated from the outdoor unit.**
   - **Return air shall be through a resin net mold resistant filter.**
   - **The indoor units shall be equipped with a condensate pan.**
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

f. The indoor units shall be equipped with a return air thermistor.

5. Unit Cabinet:
   a. The cabinet shall be affixed to a factory supplied wall/ceiling hanging brackets and located in the conditioned space.
   b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

6. Fan:
   a. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz.
   c. The airflow rate shall be available in high and low settings.
   d. The fan motor shall be thermally protected.

7. Filter:
   a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin (Floor console only).

8. Coil:
   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   c. The coil shall be a 2-row (3-row floor console only) cross fin copper evaporator coil completely factory tested.
   d. The refrigerant connections shall be flare connections.
   e. A thermistor will be located on the liquid and gas line.
   f. A condensate pan shall be located in the unit.

9. Electrical:
   a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

10. Control:
    a. The unit shall have on board controls perform input functions necessary to operate the system.
    b. The unit shall include all devices necessary to be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.

11. Optional Accessories Available:
    b. A condensate pump.

D. Floor Mounted Fan Coil Unit

1. General: The indoor unit shall be a floor mounted vertical or horizontal air handling unit, operable with refrigerant R-410A, equipped with an electronic expansion valve and direct-drive ECM type fan with auto CFM adjustment, for installation within a conditioned space. When installed in a vertical configuration it shall have top discharge air and bottom return air. When installed in a horizontal right configuration it shall have a horizontal discharge air and horizontal return air. This compact design is to be equipped with pre-painted heavy-gauge steel casing. A remote temperature sensor kit shall be required for all indoor units not utilizing the thermistor in the remote controller. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature.

2. Indoor Unit:
   a. The indoor unit components shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve,
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

control circuit board, fan motor thermal protector, brazed connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
c. Both refrigerant lines shall be insulated from the outdoor unit.
d. Return air shall be through an optional or field supplied filter.
e. Condensate draining shall be made via gravity or external condensate pump.

3. Unit Cabinet:
a. The cabinet shall be constructed with sound absorbing, foil-faced insulation to control air leakage.
b. Select an installation location with adequate structural support, space for service access and clearance for air return and supply duct connections.
c. A field supplied secondary drain pan must be installed.

4. Fan:
a. The fan shall be a direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.2 to 0.5 HP.
c. The airflow rate shall be available in high setting.
d. The fan motor shall be thermally protected.

5. Filter:
a. The return air shall be filtered by means of a field supplied filter.
b. Coil:
c. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
d. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
e. The coil shall be a 4-row cross fin copper evaporator coil completely factory tested.
f. The refrigerant connections shall be brazed connections and the condensate will be 3/4 inch outside diameter PVC.
g. A thermistor will be located on the liquid and gas line.

6. Electrical:
a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

7. Control:
a. The unit shall have onboard controls provided to perform input functions necessary to operate the system.
b. The unit shall include all devices necessary to be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.

8. Optional Accessories Available:
a. Field installed 3-20kW electric heaters. The indoor units shall have circuit breakers supplied with each electric heat kit.
b. Air filter.
c. Insulation kit for vertical and horizontal configurations.
d. Wireless controller.

E. 100% Makeup Air Unit

1. General: Indoor unit shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation into the ceiling cavity. The unit shall be capable of introducing up to 100% outside air controlled to a fixed discharge air temperature. It is constructed of a galvanized steel casing. It shall be a horizontal discharge air with horizontal return air configuration. Computerized PID
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS
control shall be used to control superheat to deliver a comfortable room temperature condition. The indoor units sound pressure shall range from 42 dB(A) to 47 dB(A) at low speed measured 5 feet below the ducted unit.

2. Indoor Unit:
   a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay and test run switch.
   b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
   c. Both refrigerant lines shall be insulated from the outdoor unit.
   d. The indoor units shall be equipped with a discharge air thermistor.

3. Unit Cabinet:
   a. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
   b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

4. Fan:
   a. The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz, with a motor output of 0.51 HP.
   c. The fan motor shall be thermally protected.

5. Coil:
   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   c. The coil shall be a 3 row cross fin copper evaporator coil completely factory tested.
   d. The refrigerant connections shall be flare connections
   e. A thermistor will be located on the liquid and gas line.

6. Electrical:
   a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

7. Control:
   a. The unit shall have onboard controls to perform input functions necessary to operate the system.
   b. The unit shall include all devices necessary to be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.

2.5 CONTROLS
A. General:
   1. Provide control devices necessary to support a fully operating system including but not limited to
      a. Local remote controllers,
      b. Centralized/multi-zone controllers,
      c. Open protocol network devices that transmit information via the communication bus and graphical user workstations.
   2. The network shall have the capability to support
      a. Operation monitoring and scheduling,
      b. Error email distribution
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

c. General user software, tenant billing, maintenance support, and integration with Building Management Systems (BMS) using open protocol via BACnet or Lonworks interfaces.

3. General Electrical Requirements: The control wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to the branch circuit selector/controller (Heat Recovery System), then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. Wiring shall be non-shielded, 2-conductor sheathed vinyl core or cable, and 18 AWG stranded copper wire.

B. Local Remote Controllers

1. The local remote controllers shall be capable of controlling up to 16 indoor units (referred to as a group). The local remote controllers shall maintain the optimal operation of the connected indoor units. Local remote controllers consist of deluxe, simplified and wireless models. No more than two of these controllers can be placed in the same group. No addressing shall be required with the local remote controllers.

2. Basic Operation: Local remote controller shall control the following group of operations:
   a. On/off, operation mode (cool, heat, fan, dry and Auto)
   b. Independent cooling and heating setpoints in the occupied mode
   c. Independent cooling setup and heating setback setpoint in the unoccupied mode.
   d. Fan speed
   e. Airflow direction
   f. The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
   g. Function key lockout

3. Programmability:
   a. Controller shall support 7-day programmable scheduling,
   b. The controller shall support auto-changeover mode for both heat pump and heat recovery systems allowing the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between cool and heat according to the room temperature and temperature setpoint.
   c. The controller shall support an auto off timer for temporarily enabling indoor unit operation using unoccupied period.
   d. The room temperature shall be capable of being sensed at either, the remote controller, the indoor unit return air temperature sensor (default), or a remote temperature sensor.

4. Display Features
   a. LED display
   b. The controller shall display Operations Mode, Setpoint, and Fan Speed.
   c. System Status icons in large font.
   d. Room temperature display
   e. On/Off status
   f. Error codes displayed in the event of a system abnormality/error
   g. Optional: The following system temperatures can be displayed to assist service personnel in troubleshooting:
      1) Return air temperature
      2) Liquid line temperature
      3) Gas line Temperature
      4) Discharge Air Temperature (depending on fan coil)
      5) Temperature used for indoor unit control.

C. Centralized/Multizone Controllers

a. The Centralized/Multizone controllers shall be capable of controlling up to 64 indoor unit groups and 128 indoor units connected to up to 10 outdoor units. The Centralized/Multizone Controllers shall be complete with power supply. The Centralized/Multizone Controllers can be used in conjunction with local remote controllers, BACnet and Lonworks interfaces to control the same indoor unit.
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

b. Basic Operation: The Centralized/Multizone controller shall control the following group operations:
   1) On/off, operation mode (cool, heat, fan, dry and Auto)
   2) Independent cooling and heating setpoints in the occupied mode
   3) Independent cooling setup and heating setback setpoint in the unoccupied mode.
   4) Fan speed
   5) Airflow direction
   6) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
   7) Remote controller permit/prohibit of ON/Off, Mode, and Setpoint.
   8) Lockout setting for touch display
   9) Indoor unit Group/Zone assignment

2. Programmability:
   a. Controller shall support weekly schedule settings
   b. Scheduling shall support unit On/Off
   c. The controller shall support multiple auto-changeover methods for both Heat Pump and Heat Recovery systems based upon the Zone configurations. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit's mode between cool and heat according to the room temperature and temperature setpoint.
   d. Controller shall support Interlock for use with 3rd party equipment to automatically control groups or zones corresponding to the change of the operation states or On/Off states of any group.
   e. Optional Digital Input/Output unit shall be available to allow On/Off based monitoring and control of 3rd party equipment.
   f. The controller shall support force shutdown of associated indoor unit

3. Display Features:
   a. Backlit LCD display
   b. Multi-language availability
   c. The controller shall display On/Off, Operations Mode, Setpoint, space Temperature, Louver Position, Fan Speed for Group/Zone.
   d. Date, day of week and time of day
   e. Daylight savings automatic adjustment
   f. Display update every 3 seconds
   g. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Set Schedule/Setback/Auto-changeover, Filter, and Screen Lock.
   h. The controller shall display the temperature setpoint in one degree increments with a range of 600°F - 900°F (160°C - 320°C).
   i. Display shall reflect room temperature 00°F - 1760°F (-180°C - 800°C) range in one degree increment.
   j. Zone configuration shall display Setpoint Range Limitation, Setback Temperature setting, and Auto-changeover for each Zone.
   k. Indoor units shall be capable of being displayed by Zone or Group.
   l. Error status shall be displayed in the event of system abnormality/error with one of two color coded icons placed over the indoor unit icon.
VARIABLE REFRIGERANT FLOW HEAT PUMP SYSTEMS

4. Software Options: All PC’s shall be field supplied
   a. Web/Email software: Each Controller shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (128 indoor unit groups with the addition of an option adapter) from a networked PC’s web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 3 email addresses).
   b. Power Proportional Distribution (PPD): The tenant billing option shall be capable of calculating VRV Controls Network equipment energy usage in kWh based on the energy consumption of the outdoor unit(s) divided among the associated indoor units. This software is used in conjunction with the Watt Hour Meter (WHM). A maximum of 3 Watt Hour Meters can be connected to the Controller. The use of the optional adapter will add an additional 3 Watt Hour Meters.
   c. HTTP Interface: This option shall be capable of creating a software interface between the VRV Controls Network and Home Automation control systems.

D. System BMS Integration
   1. The VRV/VRF system shall support integration with Building Management Systems (BMS) via a BACnet® or LonWorks interface.
   2. BMS to have capability to monitor and control of VRV indoor units.
   3. The VRV/VRF systems supplier shall cooperate fully with BMS supplier to enable them to map points into the BMS.
   4. The BMS supplier shall provide all labor and programming necessary to map VRF system points into BMS. At a minimum, through the BMS, the operator shall be enabled to monitor space temperature of all zones change space temperature setpoint of all zones, monitor fan, heating and cooling status of all zones, monitor indoor fan coil alarm, monitor status and alarms of outdoor units and schedule each zone.
   5. Operation and monitoring points include but are not limited to:
      a. On/Off (setting)
      b. On/Off (status).
      c. Alarm Sign
      d. Error Code
      e. Operation Mode (setting)
      f. Operation Mode (status)
      g. Fan Speed (setting)
      h. Fan Speed (status)
      i. Measured Room Temperature
      j. Set Room Temperature
      k. Filter Limit Sign
      l. Filter Limit sign reset
      m. Remote Control Operation (On/Off)
      n. Remote control Operation (Operation Mode).
      o. Remote Control Operation (Set Temperature)
      p. Electrical Total Power
      q. Communication Status
      r. System Forced Off
      s. Forced Thermostat off (setting)
      t. Forced Thermostat off (status)
      u. Compressor Status
      v. Indoor Fan Status
      w. Heater operation Status

2.6 REFRIGERANT GAS MONITOR

A. Where indicated on drawings provide a standalone refrigerant gas monitor and sensor to monitor and alarm for refrigerant gas leaks in the space.

B. Manufacturer to be Murco Integrated Area Monitor (IAM).
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting surfaces are ready to receive work.
B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Provide layout drawings of units, locations and power requirements to electrical installer.
C. Install air filters in unit during installation phase. Do not operate the unit without filters in place.
D. In the case of suspended units, mount the fan coil units on springs or from spring hangers as required and as shown on Drawings. Provide Mason #DNHS combination isolator hangers to fully support horizontal units hung from building framing.
E. Provide 4” high concrete pad extending 6” beyond edge of condensing unit on all sides. Attach condensing unit to concrete pad with concrete anchors and angle brackets.
F. Install 2” flexible duct connection at inlets and outlets of ducted units.
G. Install condensate drain piping and traps in accordance with manufacturer’s instructions and as shown on the Drawings. Where drainage to gravity waste is not possible provide condensate pumps.
H. Install copper refrigerant piping and insulate lines.
I. Control wiring: Communication wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to branch selector/controller (Heat Recovery system), then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote control wiring shall run from the indoor unit control terminal block to the remote controller connected with that indoor unit. Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, and 18 AWG stranded copper wire.
J. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.
K. Install a new set of filters prior to final air balance and substantial completion.
L. Provide support to BMS supplier for mapping of VRV/VRF systems points into the BMS.

3.3 MANUFACTURER’S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 1, and shall include, but not necessarily be limited to, the following:
   1. Fan Coils – Commercial
   2. Fans Coils - Residential

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230900: Controls and Instrumentation
D. Section 232113: Mechanical Insulation
E. Section 233113: Air Distribution
F. Division 26: Electrical

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430, "Central-Station Air Handling Units."

C. Codes and Standards: Provide air handling units conforming to the requirements of the latest addition of the following:
   1. Air Movement and Control Association (AMCA):
      a. 99: Standards Handbook
      b. 210: Laboratory Methods of Testing Fans for Rating [Unit shall bear AMCA Certified Rating Seal]
      c. 300: Reverberant Room Method for Sound Testing of Fans [Unit shall bear AMCA Certified Rating Seal]
      d. 301: Methods for Calculating Fan Sound Ratings from Laboratory Test Data
      e. 500: Test Method for Louvers, Dampers, and Shutters
      a. 9: Load Ratings and Fatigue Life for Ball Bearings
      b. 11: Load Ratings and Fatigue Life for Roller Bearings
      c. 900: Test Performance of Air Filter Units
   3. Air-Conditioning and Refrigeration Institute (ARI):
      a. 410: Forced-Circulation Air-Cooling and Air-Heating Coils
      b. 430: Central-Station Air-Handling Units
   4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. 15: Safety Code for Mechanical Refrigeration
   5. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
   6. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not higher than 25 and smoke developed rating not higher than 50:

SERA Architects Inc. Package 4 - 50% Construction Documents
SMALL CABINET FAN COIL UNITS

a. 70: National electrical Code
b. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
c. 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems

7. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."

8. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, installation instructions, sound and vibration test report, and bearing life calculations.

B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of one half inch to one foot. Include field fabricated mixing boxes, dampers and duct connections.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver unit to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect unit against dirt, water, chemical, and mechanical damage. Do not install damaged unit - remove from project site.

1.8 WARRANTY

A. Provide one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 FAN COIL UNIT – FOR COMMERCIAL APPLICATION

A. Manufacturers

1. Huntair or approved equal by Temtrol, Carrier, Trane, Miller-Picking, Buffalo, Energy Labs, Haakon Industries or Air Enterprises.

B. General

1. Factory fabricated fan coil units of the size, type configuration and capacity as scheduled on the drawings.

2. All pressure drops, horsepowers and dimensions shown are maximum allowable. All capacities shown are minimum allowable. All units must have AMCA certified performance data for fans tested in the unit casings. Bare fan certification without casing is not acceptable.

3. Manufacturers unable to meet this criteria will only be considered as an alternate to specified and as a deduct to base bid. Manufacturer listed by name does not imply that their standard construction meets the specifications nor that they are approved. All manufacturers are required to meet all details of this specification without exception.

C. Unit Casing
SMALL CABINET FAN COIL UNITS

1. Unit shall be constructed of no less than 16 gauge formed cold-rolled steel with minimum 1" 1.5 lb. density internal insulation. Insulation shall be attached with adhesive with all exposed edges coated to prevent erosion. All exposed metal inside and out shall be finished with at least one coat of gray enamel. Bottom access doors shall be aluminum construction 0.063 thickness painted to match unit.

D. Fan Assembly

1. Bearings shall be ball or roller type. Sleeve bearings are not acceptable. Bearings shall have replaceable inserts so entire housing need not be replaced. Bearings shall be self-aligning to assist in shaft alignment. Self-locking collars shall be proved to secure bearing to the shaft. Bearing housing shall be cast iron for strength and long life. Each bearing shall have pressure relief fittings to assure bearing seal life. Bearing life shall be minimum L-10 100,000 hour. Calculations shall be made on the basis of load ratings based on the AFBMA "Method of evaluating load ratings for ball bearings", and are the steady, radial loads that bearings can endure at various speeds for 1,500 hours with 90% of the group surviving. Calculations shall be submitted for engineer review upon request. Bearing operation shall be checked under load at the design speed. Bearing pass/fail criteria shall be based on 1987 ASHRAE Handbook, chapter 52, table 26.

2. Rotating assembly shall be steel channel type construction to provide rigid support for motor, drive, bearings, shaft and wheel. Entire assembly to be mounted on open coil type springs with seismic restraint. Assembly shall have bottom access and entire assembly shall swing down for maintenance. Assembly shall also be completely removable without disassembling unit casing.

3. Shafting shall be carbon steel, turned, ground and polished to close tolerance and oversized to insure vibration free operation. Shafts shall be selected not to exceed 75% of first critical speed. Shaft shall be cleaned and coated to protect against condensation and/or airborne contamination. The cleaning procedure shall include removing any surface rust, loose mill scale, weld spattering and sharp prominences by scraping, sanding and wire brushing to the degree specified by SSPC-SP-1 & 2. The removal of all oil, grease, dirt, salts, soil and contaminants shall be accomplished by cleaning with solvent. After cleaning, shaft shall be coated all over exposed surfaces with a lacquer based shaft protectant. Bluing pigment shall be added to facilitate visual conformation of total coverage. Removal of coating for wheel and hub service shall be achieved with the use of only a lacquer thinner.

4. Drives shall be V-belt with cast iron sheaves. Motor sheaves shall be of the adjustable pitch diameter type. Drives shall be rated at no less than 150% of nameplate horsepower.

5. Motors shall be standard NEMA frame type. All motors shall be premium efficiency type. No others are acceptable.

6. Fractional horsepower motors to be resilient mounted and integral horsepower motors to be rigid mounted to spring isolated rotating assembly frame. Power leads from motors to be field installed with flex connection to field supplied junction box allowing enough length for rotating assembly swing down.

E. Coils

1. Coils shall be ARI certified and of the same manufacturer as the unit to insure proper fit and quality. All coil casings shall be 16 gauge galvanized steel minimum or stainless steel. Copper tubes shall be minimum 5/8" diameter with a minimum thickness of 0.020 and return bends of minimum 0.035. Headers shall be non-ferrous seamless copper. Aluminum fins shall have a minimum thickness of 0.0080 and tubes shall be mechanically expanded into fin collars to provide permanent mechanical bond. No exposed copper shall show between fins.

2. Coils shall be mounted in stainless steel drain pans.

F. Filter Section

1. Filters shall be two inch thick FARR 30/30 or equal. Filter velocity shall be less than 500 FPM.
SMALL CABINET FAN COIL UNITS

2. Filter access is bottom removal unless shown otherwise on plans and schedule.

G. Unit Suspension
   1. Manufacturer to provide factory welded mounting clips for suspension of units. Clips to be capable of accepting 1/2" rod or isolators. Weights shown on plans are maximum allowable operating weights including water in coils.

H. Side Access
   1. Where shown on plans provide side access to unit components. Access panel is to be hinged and large enough to provide full access to the sections internal components. Door latch to be CAD plated spring steel manual quick release "Ludwig" latch with pressure closure mechanism. Door to be painted galvanized 16-gauge steel with pin break edge reinforcement. Door to be sealed on all four edges with gasket adhesively attached to the door panel.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Examine site to verify if site is ready to receive work. Provide a layout drawing of air handler and fan locations to electrical installer.
   C. Install minimum 30% efficiency air filters in unit during installation phase. Do not operate the unit without filters in place.
   D. Install unit supported by vibration isolation springs.
   E. Install 3" flexible duct connection at inlets and outlets of units.
   F. Install condensate drain piping and traps in accordance with manufacturer's instructions and as shown on the Drawings.
   G. Install a new set of pre-filters and final filters prior to final air balance and substantial completion.
   H. Electrical installer shall install all line voltage power wiring and conduit. Coordinate with Division 26 work.

3.2 MANUFACTURER'S START-UP SERVICES
   A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify unit mounting, verify fan rotation, verify spring isolator adjustments, verify control wiring, verify power wiring, start-up the fans, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE
A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Unit heaters.
   2. Cabinet heaters.
   3. Wall mounted electric cabinet heaters.
   4. Ceiling mounted electric cabinet heaters.
   5. Fin tube radiation.
   6. Convector.
   7. Electric Infra-red radiant heating
   8. Reheat coils (booster coils).
   10. Shell and tube heat exchangers (convertors).
   11. Plate type heat exchanger.
   12. Small air-to-air heat recovery ventilators

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230700: Mechanical Insulation
D. Section 230900: Controls and Instrumentation
E. Section 232123: Pumps and Hydronic Specialties
F. Section 233113: Air Distribution
G. Section 233412: Air Handling Equipment
H. Section 235200: Heat Generation
I. Division 26: Electrical

1.4 QUALITY ASSURANCE
A. Manufacturer's Qualifications: Provide systems that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.

B. Codes and Standards: Provide components and pumps conforming to the requirements of the latest addition of the following:
   1. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Code
      a. Section VIII D1Rules for Construction of Pressure Vessels including Addendums
      b. Section VIII D2Rules for Construction of Pressure Vessels including Addendums
      c. Section IXQualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators including Addendums
      d. B31.1Power Piping
   2. National Electrical Manufacturers Association (NEMA): Provide electrical components that comply with NEMA Standards.
      a. 70National electrical Code
HEAT TRANSFER

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for units showing dimensions, weights (shipping, installed, and operating), capacities, ratings, performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.

B. Shop Drawings: Submit manufacturer's shop drawings indicating dimensions, weight (shipping, operating), required clearances, methods of assembly of components, and location and size of each field connection.

C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, tube replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.

B. Store and protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units - remove from project site.

C. Rigging: Comply with the manufacturer's rigging and installation instructions.

1.7 WARRANTY

A. Provide general one-year (12 months) warranty. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory authorized service.

PART 2 - PRODUCTS

2.1 ACTIVE CHILLED BEAMS (HYDRONIC)

1. Active beam shall utilize induction of room air across a water coil mounted within the unit to provide sensible cooling or heating when required. The induced air shall mix with primary air and discharge evenly into the room via lateral discharge slots.

2. Active beams shall consist of an air inlet, pressurization cavity, induction nozzles, enclosed piping connections as indicated on the drawings, perforated panel face.

3. Active beams capacity shall be tested and certified by manufacturer in accordance with EN standard 15116 to meet the performance listed on the schedule. Manufacturer shall have a factory testing facility available to perform test of units in accordance with said standard as required. Upon request, up to 1% of units for the project can be tested in accordance with the standard.

4. Casing: air plenum shall be constructed of 24 gauge galvanneal steel, consisting of at least one (1) air inlet. The frame shall be constructed of 0.060" aluminum extrusion.

5. Water Coil: Shall consist of copper tubing mechanically expanded into aluminum plate fins.

2.2 PASSIVE CHILLED BEAMS (HYDRONIC)

A. General:

1. The contractor shall furnish and install beams specified in schedule and indicated on plans. Contractor shall verify beams match architectural RCP plans. Contact engineer/architect if they do not match.

B. The Architectural Chilled beam shall be constructed with copper tubing fitted into engineered heat sinks for optimal heat transfer from the cooling or heating fluid to the sail face. The beam shall be constructed of one piece extruded aluminum designed to be visually appealing and feature integrated heat sinks designed to retain the copper pipe by interference, without the need for auxiliary clips for pipe retention, evenly applying pressure on the pipe and maximizing the contact surface area as well as heat conduction.

C. The beam shall be constructed of extruded sections with a profile designed to optimize heat transfer by convection as well as some radiation as surrounding air falls though openings between profiles.
HEAT TRANSFER

D. The beam shall feature a frame with integrated hanger brackets and shall be constructed of steel.

E. Manufacturer shall provide water pressure drop data as well as heat output data derived from tests in accordance with DIN 4715.

F. Manufacturer: Price, or approved equal by Barcol Air, Semco, TWA, Lindab or Trox.

2.3 UNIT HEATERS (ELECTRIC)

A. General:
   1. The contractor shall furnish and install electric unit heaters of type, size, and voltage specified in schedule on plans. Heaters shall be installed and wired in accordance with the manufacturer's recommendations and applicable national and local codes.

B. Casing:
   1. Casings shall be fabricated of die formed heavy gauge steel and finished in high gloss, baked enamel. Supply air shall be drawn and discharged through an outward drawn venturi. Adjustable discharge louvers shall be provided to control the direction of airflow. A large hinged access door shall extend the width of the heater and be locked in position by quarter turn fasteners. Heater and supply wiring diagram shall be permanently attached to the inside of the access door.

C. Elements:
   1. Elements shall be high mass, all steel, tubular finned type, copper brazed.

D. Motors:
   1. Motor shall be totally enclosed, all angle industrial rated. All units 3.3 through 20 Kw will utilize sealed bearings to ensure permanent lubrication. 25 through 50 Kw units are provided with a two speed, permanent capacitor type, lubricated for 5 years of continuous or ten years of intermittent use.

E. Fan Blades:
   1. Fan blades shall be of the axial flow type designed for quiet, efficient operation. Fan speed shall not exceed 1,600 rpm.

F. Wiring:
   1. Heaters shall be designed for a single circuit, with elements, motor, and control circuits subdivided with factory fuses to conform to the National Electric Code and Underwriter's Laboratory, Inc. Standard 1025. All three-phase heaters shall have balanced phases.

G. Thermal Overload Protection:
   1. All heaters shall be equipped with automatic reset thermal overloads that shut down the element and motor if safe operating temperatures are exceeded.

H. Controls:
   1. Contactors and control circuit transformers, where required, shall be factory installed and wired. Only direct line supply and thermostat connections are field wired. Two stage operation is provided on all units 25 Kw and larger. Built-in fan override shall be provided to purge unit casing of excess heat after unit shutdown. The units shall be listed under the Re-examination Service of Underwriters' Laboratories, Inc. Units shall be warranted to be free from defective material and workmanship for a period of one year with the exception of the heating elements that shall be warranted for 5 years.

I. Control Options:
   1. Power disconnects supplied for field installation where applicable shall disconnect all ungrounded connectors in the "Off" position.
   2. Thermostat shall be (unit mounted) (wall mounted) and shall be heavy-duty hydraulic actuating type. Thermostat range shall be 45° F to 90° F. Unit mounted thermostat shall be rendered tamperproof by removing the temperature adjustment knob.
   3. Independent fan operation of summer air circulation shall be provided from a line or low voltage (unit mounted) (wall mounted) fan switch.
HEAT TRANSFER

4. Combination low voltage wall thermostat and fan switch shall be provided to give remote control of thermostat and fan.

5. Stratification thermostat with a range of 70°F to 130°F shall be available for units mounted in the vertical discharge position to provide an energy saver cycle recovering warm stratified air.

J. Manufacturer:
1. Berko, Trane, Q-Mark, Reliance, or approved equal.

2.4 UNIT HEATERS (HYDRONIC)

A. General:
1. The contractor shall furnish and install [hot water] [steam] unit heaters of type, size, and voltage specified in schedule on plans. Heaters shall be installed and wired in accordance with the manufacturer's recommendations and applicable national and local codes.

B. Vertical Discharge Units:
1. Casing:
   a. Casings shall be formed by two steel plates. Bottom plate to form orifice for air delivery. Air ports stamped in top plate to be standard and easily removable for low final air temperature.

2. Fan:
   a. The high efficiency fan with aluminum blades shall be factory balanced and sturdy for standard or sparkproof applications.

3. Coils:
   a. Hot water steam coils are to be rectangular 3 or 4 sided, one pass, multiple circuits, with aluminum fins mechanically bonded to tubes.
   b. Standard coils are to be seamless copper tubing. Coils to be tested at 375 psig under water. Supply and return connections are to be steel pipe. Standard coils to have 0.025 copper tubing suitable for use on steam pressure to 75 psi or hot water up to 225 psi or 325°F.
   c. Provide heavy .049 red brass tubing suitable for 200 psig steam or up to 425°F water at 300 psig.
   d. Provide 0.049 cupro-nickel tubing suitable for 400 psig steam or up to 450°F water at 400 psig.
   e. Provide 0.049 steel tubing suitable for 450°F water at 400 psig.

4. Motors:
   a. Standard motors are 115/60/1, totally enclosed, with thermal overload protection for all units through size 280P. Standard motors for 42P, 64P and 80P are shaded pole, sleeve bearing. The 102P motor is permanent split capacitor type with sleeve bearings. Motor for unit sizes 122P through 280P are permanent split capacitor types with permanently lubricated ball bearings.
   b. Motors used on unit sizes 336P through 720P are 230/460/60/3, totally enclosed, with permanently lubricated ball bearings.
   c. Unit sizes smaller than 336P are also available with 230/400/60/3 motors.
   d. All motors fractional hp and integral hp, have Class "B" insulation. The 115/60/1 motors used as standard on unit sizes 42P through 102P can be operated at multiple speeds with the addition of a solid-state control.
   e. All units available with explosion proof motors. Only sizes 42P, 64P, 102P and 146P are available from stock with 115/60/1 explosion proof motors.
   f. All explosion proof motors are 1,140 rpm.

5. Louver Cone Diffuser:
   a. (When specified) Provide for complete versatility in air diffusion patterns. Adjustable 18 gauge steel blades held in set position by spring steel clips.
HEAT TRANSFER

C. Horizontal Discharge Units:
   1. Casing:
      a. Casings shall be two-piece with "picture frame" front formed into wraparound sides, top and bottom. Adjustable horizontal louvers are to be standard. Provide 18 gauge back panel with deep draw fan orifice for extreme rigidity. Steel supply and return pipe tap connectors to be bolted to back. Casings to be phosphatized to prevent corrosion and painted with blue gray baked enamel.
   2. Fan:
      a. The high efficiency fan with aluminum blades shall be quiet, factory balanced and sturdy for standard or sparkproof applications.
   3. Coils:
      a. Hot water steam headerless coils are to be single tube, single serpentine on all sizes except 230 through 354 which are to have two circuits. Fins are to be aluminum mechanically bonded to seamless copper tubing. All coils to be one row deep in air flow direction. Coils to be tested at 375 psig air under water.
      b. Standard coils are to have 0.031 copper tubing suitable for use on steam pressures to 75 psi or hot water up to 200 psi or 325°F.
      c. Provide heavy 0.049 red brass tubing suitable for 200 psig steam or 390°F water at 260 psig.
      d. Provide 0.031 cupro-nickel tubing suitable for 450°F water at 400 psig.
      e. Provide 0.049 steel tubing suitable for 450°F water at 400 psig.
      f. (When specified) Provide coils with turbulators for high performance on hot water.
      g. (When specified) Provide coils with fin series 132 for high performance on hot water or steam.
      h. (When specified) Provide bypass Model S units with modified coils for air bypass. Unit sizes have odd number (19, 77, 243, etc.).
   4. Motors:
      a. Provide totally enclosed, 115/60/1 Class "B" insulated shaded pole and PSC motors as STD. 1/25 through 1/8 hp are to be sleeve bearing, 1/6 through 3/4 hp are to be ball bearing. All single-phase motors are to have built-in overload protection. Sleeve bearing motors are to be oiled. Ball bearing motors are to be permanently lubricated. The 115/60/1 motors used as standard on unit sizes 18S through 100S can be operated at multiple speeds with the addition of a solid-state control.
      b. All units available with explosion proof motors. Only sizes 18S, 42S, 90S and 126S are available from stock with 115/60/1 explosion proof motors.
      c. All explosion proof motors are 1,140 rpm.
   5. Louver Fin Diffuser:
      a. (When specified) For versatility in lateral diffusion, used with standard louvers, provides 4-direction control. Ships separately and clips onto horizontal louvers.

D. Manufacturer:
   1. McQuay, Trane or approved equal by Modine or Dunham-Bush.

2.5 CABINET HEATERS

A. General:
   1. Basic Unit:
      a. Includes chassis, coil, fanboard, fanwheel(s), housing(s), motor, and insulation. Chassis is galvanized steel wraparound structural frame with all edges flanged. Insulation is faced, heavy density glass fiber.
HEAT TRANSFER

b. Vertical cabinet models; 16 gauge steel front panels and 18 gauge steel end and top panels have channel formed edges around entire panel perimeters. Front panel insulated over entire coil section. Integral, stamped outlet grilles have 15° deflection from vertical. Stamped lattice discharge grilles on inverted airflow models. Access door on coil connection side of unit. Front panel removable without tools.

c. Vertical recessed models; 16 gauge steel, four side overlap front panels, with M-shaped stiffener running entire panel length as standard. Integral, stamped, inlet and outlet grilles have 15° downward deflection. Front panel insulated over entire coil section. Front camlocked access doors on right hand side of unit. Front panel removed with two screws. Panel depths from 5/8" to 5-1/8" in 800-1,800 cfm units.

d. Horizontal cabinet models; 18 gauge steel panels. Bottom and end panels have channel formed edges around entire panel perimeter. Integral, stamped outlet grilles have 15° downward deflection. Stamped lattice inlet grilles. Bottom panel hinged at front and camlocked at back.

e. Horizontal recessed models; 18 gauge steel, removable, four side overlap bottom panel adjustable 3/8" with full length, piano type hinge at back and camlocks at front.

f. Cabinet finish: All cabinet parts cleaned, bond erized, phosphatized, and painted with light gray baked on enamel finish as standard. Optional baked on enamel in eight decorator colors (chestnut brown, forest green, platinum gray, redwood, pale gold, flat black, bronze tone, or shell white) are available. Standard and optional finish meet Corps of Engineers specifications CE301.37 (salt spray test).

2. Coils:

a. Water coils; 5/8" OD seamless copper tubes mechanically bonded to configured aluminum fins with continuous fin collars and sleeved coil end supports. Maximum working pressure 300 psig, factory burst test 450 psig (air), and leak test 300 psig (air under water). Maximum entering water temperature 275° F. Supply and return connections on same side of units on all models and sizes.

b. Steam Coils; 1 inch OD seamless copper tubes mechanically bonded to configured aluminum fins with continuous fin collars and sleeved coil end supports. Maximum working pressure 75 psig for Type B steam coil, and 100 psig on Type F steam distributing coil. Factory leak test 250 psig (air under water). Maximum entering steam temperature 325° F for standard coil (Type B) and 400° F for steam distributing coil (Type F). Steam distributing coils have cast iron headers. Supply and return connections on same side of units on all models and sizes.

c. Electric Heating Coils: Hydronic type finned tube construction with resistance elements inserted in tubes on 200-600 cfm units; spiral sheath type on 800-1,800 cfm units. Units factory wired with unit mounted heat switch, magnetic contactors, high temperature cutout safety control, and fan override thermostat.

3. Fans:

a. Fan wheels centrifugal, forward curved, double width of non-corrosive, molded, fiberglass reinforced thermo-plastic material on all units except electric heat and inverted airflow models which use aluminum. Fan housings of formed sheet metal on 200-600 cfm units; 800-1,800 cfm units have end caps made of non-corrosive molded, fiberglass reinforced thermo-plastic material, and fan scrolls of galvanized steel.
HEAT TRANSFER

4. Motors:
   a. All motors have integral thermal overload protection and start at 87% of rated voltage. Motors operate satisfactorily at 89% of rated voltage on all speed settings and at 10% over voltage without undue magnetic noise. Temperature rise by winding resistance method does not exceed 60°C (shaded pole motors) and 50°C (PSC motors) on high speed. All motors factory run tested assembled in unit prior to shipping. Motor cords quickly detachable at junction box by locking prong connector.

5. Filters:
   a. Removable from vertical cabinet models without removing front panel; from horizontal units by pivoting hinged bottom panel. 1" woven glass filters standard.
   b. Options include 1/2" permanent, cleanable aluminum mesh; 1/2" renewable media in permanent aluminum frame; and 1" replaceable media of woven glass fiber with 1" permanent aluminum frame.


B. Accessories:
   1. Aluminum Wall Boxes: Coated with methacrylate resin lacquer. (Anodized optional) 200-600 cfm, sizes have stamped integral eliminators and galvanized, wire mesh insect screen. 800-1,200 cfm sizes heavy gauge aluminum with W-shaped, eliminator type vertical louver.
   2. Discharge Grille Panels: Stamped 18 gauge galvanized steel (02-06); stamped without access door (08-18).
   4. Recessing Flanges: 18 gauge steel flanges for recessing vertical cabinet and horizontal cabinet models into wall or ceiling.
   5. Motor Starters: Isolates unit from electric power source for maintenance. Thermal overload device protects motor. Overload mechanism reset by moving toggle switch to "off" and then "on" position (200-600 cfm).
   6. Transformers: Totally enclosed transformers with Class F insulation to step down power voltage to 115 volts for motor control circuit. Transformers factory mounted.
   8. Tamperproof Front Panel: Key operated locking device. Vertical cabinet (200-600 cfm).
   9. Subbase: 18 gauge steel in heights of 2 to 6 inches in 1 inch increments (vertical cabinet, 200-600 cfm).
  10. Extended Motor Oilers: Plastic tubes terminate beneath top discharge grille of vertical cabinet models with top discharge grilles (200-600 cfm). Tube openings are covered.

C. Manufacturer:
   1. McQuay, Trane or approved equal by Modine, Vulcan, or Dunham-Bush.

2.6 WALL MOUNTED ELECTRIC CABINET HEATERS

A. General: Provide heavy duty electric wall heater for surface mount. QDOT, Markel, or equal.

B. Heater element: Non-glowing design of 80/20 nickel-chromium resistance wire enclosed in steel sheath to which plate fins are copper brazed.

C. Fan and motor: Aluminum bladed fan with totally enclosed motor.

D. Fan Delay Switch: Fan control shall be of bi-metallic, snap-action type and shall activate fan after heating element reaches operating temperature. Fan shall continue to operate after the thermostat is satisfied until heating element is cool.
HEAT TRANSFER

E. Thermostat: Tamper proof thermostat shall be of the bimetallic, snap-action type with enclosed contacts. It shall be completely concealed behind the front cover to become tamper proof.

F. Thermal Cutout: Provide cutout built into the system to shut off heater in the event of overheating.

G. Disconnect: A double-pole single throw disconnect switch shall be mounted on the back box for positive disconnect of the power supply. It will be completely concealed behind the front grid panel.

H. Front Panel: Bar grille type constructed of 16-gauge cold-rolled steel, welded into a uniform grille and finished in bronze brown baked enamel to direct the warmed air toward the floor.
   1. Back Box: 20 gauge galvanized steel with knockouts for power leads. Box to be used with the mounting frame for surface mounting application.

2.7 CEILING MOUNTED ELECTRIC CABINET HEATERS

A. General: Provide heavy duty electric heater for flush surface ceiling mount. QDOT, Markel 3480 series, or equal.

B. Heater element: Non-glowing design of 80/20 nickel-chromium resistance wire enclosed in steel sheath to which plate fins are copper brazed.

C. Fan and motor: Aluminum bladed fan with totally enclosed motor.

D. Fan Delay Switch: Fan control shall be of bi-metallic, snap-action type and shall activate fan after heating element reaches operating temperature. Fan shall continue to operate after the thermostat is satisfied until heating element is cool.

E. Thermostat: Tamper proof thermostat shall be of the bimetallic, snap-action type with enclosed contacts. It shall be completely concealed behind the front cover to become tamper proof.

F. Thermal Cutout: Provide cutout built into the system to shut off heater in the event of overheating.

G. Disconnect: A double-pole single throw disconnect switch shall be mounted on the back box for positive disconnect of the power supply. It will be completely concealed behind the front grid panel.

H. Ceiling Panel: Similar in appearance to ceiling mounted louver faced grille. Grille assembly shall be constructed of a one piece heavy gauge steel with ¼” square slots for return air and concentric rings for uniform supply air discharge.

I. Back Box: 20 gauge galvanized steel with knockouts for power leads. Box to be used with the mounting frame for surface mounting application.

J. Required Options:
   1. Tamper Proof Built-in thermostat for 3-phase heater
   2. Disconnect switch

2.8 CONVECTORS

A. General:
   1. The contractor shall furnish and install convectors as indicated and scheduled on the plans. All ratings shall be in accordance with Commercial Standard CS 140-47. Units shall be installed in a neat and workmanlike manner in accordance with the specifications and the manufacturer's recommendations.

B. Heating Elements:
   1. Convector elements shall be constructed of copper tubes expanded and rolled into cast iron headers with contact further strengthened by brass bushings, aluminum fins, ribbed steel side plates and fin tube supports. Fins shall have integral fin collars which space the fins and provide fin-to-tube surface firmly bonded to the tube by mechanical expansion of the tube to insure durability, eliminate noise from loose fins and insure performance at cataloged ratings. End supports shall carry weight of element and be designed to fit over header to provide completely free area from tubes to header. No solder or welded joints or compression couplings shall be permitted. All elements shall withstand 100 lb. air pressure factory tested under water.
HEAT TRANSFER

C. Enclosures:
   1. Free Standing and Wall Cabinets: Cabinet front and top panels shall be (14) (16) gauge steel. End panels shall be no less than reinforced 18 gauge. Cabinet back shall be phosphatized, galvanized; front, top and sides shall be phosphatized and painted inside and out with standard beige baked enamel finish. Fronts shall be secured in place by quick opening front panel fasteners. Cabinet top line rigidity shall be provided by a roll formed channel section that also permits hinged type mounting of the cabinet front panel for easy access. Access doors are not required with this construction. Convector styling shall match fin tube enclosure styling. All cabinets shall have recessed, framed air outlets for storing linear styling. Top outlet style cabinets shall have a bar type outlet grille made of extruded aluminum.
   2. Recessed Cabinets: Cabinets shall have a one piece (14) (16) gauge steel front panel. Flanges on enclosure at sides and top shall serve as plaster stops. The front shall be sealed against the flanges with a 3/8" sponge rubber to prevent any air leakage and wall streaking. Front panels shall be held in place by quick opening front panel fasteners. Cabinet back and sides shall be phosphatized galvanized steel. Front panels shall be phosphatized and painted inside and out with standard beige baked enamel finish.

D. Color Finishes:
   1. Units are also available with other baked-on enamel finishes. Provide color as selected by Engineer. [When painting with latex paint an intermediate alkyd primer coat is required for best paint adhesion. See Engineering Bulletin EB-UNT for complete details.]

E. Options:
   1. Dampers are factory installed on the heating element and are operated by a chain and knob assembly. In the closed position, heating capacity is reduced 70 percent.
   2. Access Doors: 6” x 7” with spring catch or Allen head camlock fasteners installed flush in the front panel.
   3. End Pockets: 6” or 12” wide, available at each or either end for field installing of valves, traps and piping.
   4. Insulation: 1/2” fiberglass factory installed on the inside of the back panel only.
   5. Air Vent Assembly and Air Chamber: Used for venting to prevent the accumulation of air in the convectory heating element for maximum system effectiveness.
   6. Bottom Overlap: (Four side overlap) For recessed convectors only to mount recessed convectors above the floor with the bottom of the unit overlapping the wall.

F. Manufacturer: Jaga Maxi or approved equal by Vulcan or Dunham-Bush.

2.9 HEAT RECOVERY (HEAT PIPE)

A. General:
   1. Furnish heat recovery unit of the air-to-air heat pipe exchanger type as shown in the equipment schedule.
   2. Heat recovery unit shall require no continuously moving parts for heat transfer between exhaust and supply air streams.

B. Heat Exchanger Construction
   1. Tube core shall be seamless aluminum tubing permanently expanded into the fins to form a firm, rigid and complete metal pressure contact between the tube and fin collar at all operating conditions.
   2. Secondary surface shall be continuous plate type aluminum fins of corrugated design to produce maximum heat transfer efficiency.
   3. Basic capillary wick shall be an integral part of the inner wall of the tube to provide a completely wetted surface for maximum heat piping capacity with minimum heat transfer resistance.
   4. Refrigerants used shall be classified as Group 1 in ANSI Safety Code for Mechanical Refrigeration.
   5. A vertical partition shall be provided, and located as specified in the schedule, to isolate the exhaust and supply airstreams from each other to prevent cross-contamination.
HEAT TRANSFER

6. Heat exchanger pressure drop shall be no more than 0.8" w.g. at rated cfm and have an efficiency of no less than 68% at rated flow conditions.

C. Manufacturer:
   1. QDOT, IEC, Des Champs Labs, CTSI or approved equal.

2.10 SHELL AND TUBE HEAT EXCHANGER (CONVERTER)

A. General:
   1. Furnish and install shell and tube type steam to hot water heat exchanger of capacity and size as shown on plans. Installation in accordance with manufacturer's recommendations.

B. Type:

C. Materials:
   1. Shell - steel.
   2. Tubes - 3/4" OD copper.
   3. Heads - cast iron or steel.
   4. Tube sheets - steel.
   5. Tube supports - steel.

D. Construction:
   1. A manufacturer's data report for pressure vessels, Form No. U-1 as required by the provisions of the ASME Code Rules, is to be furnished to the engineer for the owner upon request. This form must be signed by an authorized inspector, holding a National Board commission, certifying that construction conforms to the latest ASME Code for pressure vessels for:

      Shell side _____ PSIG design pressure at ______ ° F
      Tube side _____ PSIG design pressure at ______ ° F

   As detailed in Form No. U-1. The ASME "U" symbol should also be stamped on the heat exchanger. In addition, each unit is registered with the National Board of Boiler and Pressure Vessel Inspectors.

E. Installation:
   1. The steam supply line shall be adequately sized and equipped with a steam control valve. The steam control valve shall be actuated by a thermal control element in the hot water line from the exchanger adjusted and set to maintain a temperature of ______ ° F in the water leaving the exchanger.
   2. Exchanger shall have adequate condensate return line equipped with proper trap for steam system.
   3. Exchanger shall be equipped with proper vacuum breaker and/or vent as required.

F. Manufacturer: Bell & Gossett or approved equal by Taco.

2.11 PLATE TYPE HEAT EXCHANGER

A. General:
   1. Furnish and install plate type heat exchanger of capacity and size as shown on plans. Install in accordance with manufacturer's recommendations.
   2. Heat exchanger selections shall be verified by the manufacturer to provide required heat transfer surface area for specified capacity and pressure drop conditions.

B. Channel Plates:
   1. Corrugated channel plates shall be type _____ stainless steel (or ______).

C. Gaskets:
   1. Channel plate ports to be double gasketed to prevent mixing or cross-contamination of hot side and cold side fluids. Gaskets to be Nitrile (or ________).

D. Carrying Bars:
HEAT TRANSFER

1. Channel plate carrying bars to be stainless steel.

E. Frame Plates & Pressure Plates:
1. Fixed frame plates and movable pressure plates to be corrosion resistant epoxy painted carbon steel.

F. Connections:
1. Piping connections 2” and smaller to be stainless steel NPT nozzles.
2. Piping connections 4” and larger to be studded port design to accept ANSI flange connections.
3. Connection ports to be integral to the frame or pressure plate.

G. Splash Guards:
1. Finished units to be provided with OSHA required, formed aluminum splash guards to enclose exterior channel plate and gasket surfaces.

H. Design Pressure/Temperature:
1. Units to be designed for minimum 150 psig (or ____ psig) working pressure at ______ °F design temperature. Assembled units to be hydrostatically tested at 1.5 times full differential design pressure.

I. Unit Size:
1. Heat exchanger plan dimensions shall not exceed ______ height x ______ width x ______ length.

J. Construction:
1. A manufacturer's data report for unfired pressure vessels, Form No. U-1 as required by the provisions of the ASME Code Rules, is to be furnished to the engineer for the owner. This form must be signed by a qualified inspector, holding a National Board Commission, certifying that construction conforms to the latest ASME Code for unfired pressure vessels for: ____ PSIG working pressure at ______ °F as detailed in Form No. U-1. The ASME "U" symbol should also be stamped on the heat exchanger. The manufacturer must be registered with the National Board.

K. Manufacturer:
1. Heat exchangers shall be Bell and Gossett Model No. GPX ______ , Alfa Laval, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment, unless otherwise shown or noted on the Drawings, is to be installed in accordance with industry standards and manufacturer's recommended installation instructions.

B. Provide vibration isolation, inertia bases, seismic snubber, flexible pipe connections, etc, as specified in related specification sections.

C. Mechanical contractor to assist testing and balancing contractor in verifying correct pump rotation and system operation.

D. Flush and clean equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls.

E. Contractor to coordinate all electrical requirements with electrical contractor.

3.2 INSTALLATION SPECIFICS FOR AIR-TO-AIR HEAT RECOVERY VENTILATOR

A. Ductwork: The installer shall supply, install, test and commission all interconnecting ductwork for the energy recovery unit.

B. Ductwork sizing, layout, fittings, etc shall be in strict accordance with the design requirements.
HEAT TRANSFER

C. The outside air and exhaust air ducts connected to exterior louvers must be covered with heat insulating material in order to prevent condensation from forming and must be tilted at a gradient of 1:30 toward the outdoor louver.

3.3 MANUFACTURER'S START-UP SERVICES

A. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify pump systems mounting, verify piping installation, verify control wiring, verify power wiring, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the job site.

END OF SECTION
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Compliance with all codes and standards applicable to this jurisdiction
   2. Shop Drawings for Equipment
   3. Coordination Documents
   4. Record Drawings
   5. Start-up Service and Building Commissioning
   6. Instruction, Maintenance, and O & M Manuals
   7. Work associated with Delivery, Storage, and Handling of products
   8. Work associated with provision of Temporary Facilities
   9. Preparation of Posted Operating Instructions
   10. Meeting Project Safety and Indemnity requirements
   11. Proper Cleaning and Closing
   12. Supplying proper Warranty information
   13. Supply specified Guarantee documentation
   14. Design and provision of Supports and Anchors
   15. Access Panels and Doors
   16. Identification Markers
   17. Demolition/Remodel Work

1.3 DESCRIPTION OF WORK

A. The Contract Documents, including Specifications and Construction Drawings, are intended to provide all material and labor to install complete power distribution, auxiliary power production, lighting systems for the building and shall interface with all existing building systems affected by new construction.

B. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the fixtures, equipment, and raceways and are not to be scaled; all dimensions and existing conditions shall be checked at the building.

C. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:
   1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
   2. Before proceeding with work check and verify all dimensions.
   3. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
COMMON WORK RESULTS FOR ELECTRICAL

4. 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.

5. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible, including during bidding period.

1.5 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 26 Electrical sections included herein.

B. Division 33: Utility Site Work.
   1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.
   1. All concrete work for Mechanical Division shall be included in Division 23 under the appropriate Sections and shall include:
      a. Concrete curbs and housekeeping pads for the mechanical equipment.
      b. Thrust blocks, pads, and boxes for mechanical equipment.
      c. Coordination of floor drain and floor sink installations in sloped floors.

D. Division 07: Thermal and Moisture Protection.
   1. Flashing and sheet metal
   2. Sealants and caulking
   3. Firestopping

E. Division 09: Painting:
   1. Division 09 installer shall perform all painting, except where specifically stated otherwise in Division 09.

F. Division 21: Plumbing is related to work of:
   1. Power connections to all plumbing equipment
   2. Installation of controllers and disconnect furnished by Division 21 contractor.

G. Division 23: HVAC is related to work of:
   1. Power connections to all mechanical equipment
   2. Installation of controllers and disconnect furnished by Division 23 contractor.

H. Division 28: Electronic Safety and Security is related to work of:
   1. Power connections to equipment

1.6 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 26 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

D. All electrical work shall comply with the Americans with Disabilities Act (ADA).

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:
   1. Building Codes enforced by the Authority Having Jurisdiction in Oregon:
COMMON WORK RESULTS FOR ELECTRICAL

1. Oregon Structural Specialty Code (OSSC) with amendments based on 2009 International Building Code (IBC)
2. 2007 Oregon Fire Code (Based on the 2006 International Fire Code)
3. 2011 National Electric Code (NEC) with 2011 (OESC) State Amendments
4. Local, city, county and state codes and ordinances
5. Local Bureau of Buildings
6. Local Health Department
7. Local and State Fire Prevention Districts
8. State Administrative Codes

1.7 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.
B. Review contract documents and technical specifications for extent of new work to be provided.
C. Provide and pay for all permits, licenses, fees and inspections.
D. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for access.
E. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications in Divisions 02 through 26 for rough-in requirements.
F. Coordinate electrical equipment and materials installation with other building components.
G. Verify all dimensions by field measurements.
H. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
I. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
J. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
K. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials. Contractor to provide for all cutting and patching required for installation of his work unless otherwise noted.
L. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
M. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components.
N. Coordinate the installation of electrical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.
O. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
P. All materials located within air plenum spaces, air shafts, and occupied spaces shall have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles,
COMMON WORK RESULTS FOR ELECTRICAL

and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

Q. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.8 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting his work. It is the specific intention of this section that the contractor's scope of work shall include:
   1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
   2. Minor deviations from the electrical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange his work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the "Mechanical Work." Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations in order to avoid conflict shall be permitted where the design intent is not altered.

E. Advise the Architect, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

1.9 PRODUCT SUBSTITUTIONS

A. The Contractor shall certify the following items are correct when using substituted products other than those scheduled or shown on the drawings as a basis of design:
   1. The proposed substitution does not affect dimensions shown on drawings.
   2. The proposed substitution does not affect the electrical characteristics shown on the drawings.
   3. The Contractor shall pay for changes to building design, including engineering design, detailing, structural supports, and construction costs caused by proposed substitution.
   4. The proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
   5. Maintenance and service parts available locally are readily obtainable for the proposed substitute.

B. The Contractor further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

C. The Contractor agrees that the terms and conditions for the substituted product that are found in the contract documents apply to this proposed substitution.

1.10 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with Division 01 requirements.
COMMON WORK RESULTS FOR ELECTRICAL

B. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Architect for approval.

C. Submittals and Shop Drawings shall be submitted as a complete package bound in a 3-ring binder with tabs for each specification section. The approved submittals shall be converted into Operations & Maintenance Manuals at the completion of the project. Submit six (6) typed copies of submittals. Refer to Division 01 for additional requirements.

1.11 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application of firestopping specified in Division 07 "Through – Penetration firestop systems."

1.12 COORDINATION DOCUMENTS

A. The Contractors shall prepare coordinated Shop Drawings to coordinate the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances. The Drawings shall include all mechanical rooms and floor plans. The Drawings shall be Overlay Drawings showing each discipline on a single sheet. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Architect and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide reasonable maintenance access requirements. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor, Architect, and Owner. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. Plans are to incorporate all addenda items and change orders.

C. Advise the Architect in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Architect of conflict.

D. Provide means of access to all junction boxes, disconnect switches, controllers, operable devices, and other apparatus that may require adjustment or servicing.

E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

F. Provide copy of Record Drawings to Commissioning Agent for their use when doing their work.
COMMON WORK RESULTS FOR ELECTRICAL

1.13 RECORD DRAWINGS

A. Before commencing installation, obtain an extra set of prints from Architect, marked “Record.” Keep this set of Drawings at the job site at all times, and use it for no other purpose but to mark on it all the changes and revisions to the Contract Drawings resulting from coordination with other trades. At the completion of the project,
   1. Edit project AutoCAD files to incorporate all site markups, changes, and revisions to the Contract Drawings. Submit plots of Record Drawings and six copies CD Roms labeled with all record AutoCAD drawing files.
   B. Provide copy of Record Drawings to Testing and Balancing Contractor for use when doing his work.
   C. Mark Drawings to indicate revisions to raceways; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground raceways; concealed equipment, dimensioned to column lines; Change Orders.
   D. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.
   E. Refer also to Special Conditions in Division 01 for full scope of requirements.

1.14 DEMOLITION/REMODEL WORK

A. Refer to Division 01 section on Summary of Work for requirements on working in Owner-occupied areas of the existing building and Division 02 section on selective demolition. The following expand the requirements specified in Division 01 and 02.
   B. Existing equipment that is removed and not scheduled to be reused shall remain the property of the Owner unless specifically indicated otherwise and shall be stored in a location designated by the Owner. Miscellaneous materials that are removed shall become the property of the Contractor.
   C. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being energized.
   D. Revise panelboard schedules to reflect removal or relocation of equipment. Circuit integrity of equipment shall be left intact.
   E. Where remodeling interferes with existing circuits and equipment which is not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the project.
   F. The project involves renovation and remodel of the existing building. On the drawings, certain renovation symbols are used. These symbols are amplified as follows:
      R = Existing items to be removed. Contractor shall remove the existing item and turn over to the Owner. The existing wiring shall be removed. Where the raceway serving the equipment is accessible (via removal of suspended ceiling, crawl space, etc.) The raceway shall also be removed. Where the removal of a raceway leaves visible evidence on an existing surface which is not being repaired or replace as part of the Work, this Contractor shall repair the surface. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed. Where the concealed raceway is uncovered by demolition performed as part of the Work, the raceway shall be removed (or extended to new location if appropriate).
      E = Existing item to remain in place. Contractor shall perform the following function based upon the item to remain:
         Luminaries - Clean and relamp.
         Switches - Leave as existing.
COMMON WORK RESULTS FOR ELECTRICAL

Receptacles - Leave as existing.

RL = Existing item to be relocated. Contractor shall remove the existing item, and store in a safe place. The existing item shall be relocated to the new position as called for on the drawings. At contractors option, the existing wiring may be extended, or new wiring may be run from the source. Based upon the item to be relocated, the Contractor shall perform the following function:

Luminaires - Clean and relamp.
Switches - Replace.
Receptacles - Replace.

G. The Contractor shall remove all distribution equipment, conductors, etc. which are indicated to be removed or which must be removed to accommodate demolition. Equipment to be removed may require reworking conduit and wiring in order to maintain service to other equipment.

H. Where remodeling interferes with circuits serving areas outside of the project or phase limits or which are remodeled in later phases of the project, circuits shall be reworked or temporary circuits provided as required.

I. Existing equipment and circuiting shown are based upon field surveys and/or Owner furnished drawings. The Contractor shall verify conditions as they exist with necessary adjustments being made to the drawing information.

J. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated within the Contract Documents.

K. Electrical Outages:
   1. Contractor shall submit a Method of Procedure (MOP) for each outage to the Owner detailing the reasons for the outage, areas affected, sequence of procedures to accomplish work, estimated maximum duration, the date and time of day outage will occur. The Contractor shall meet with the Owner to set a schedule and date for the outage based upon the MOP. Due to the critical implications of power outage, the Owner may direct the Contractor as to the time of day or night and date an outage may take place. A 7 day notice is required.

1.15 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping shall be stored in bundles covered with visqueen. Piping showing signs of rust shall be removed from site and replaced.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.16 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

B. No act, service, drawing, review, or Construction Review by the Owner, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.
C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.17 CLEANING AND CLOSING
A. All work shall be inspected, tested, and approved before being concealed or placed in operation.
B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Architect.

1.18 WARRANTIES
A. All equipment shall be provided with a minimum one-year warranty to include parts and labor. Refer to individual Equipment Specifications for extended or longer-term warranty requirements.
B. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
C. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

1.19 GUARANTEE
A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year after the Date of Final Acceptance, ordinary wear and tear excepted.
B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in his work.

PART 2 - PRODUCTS

2.1 GENERAL
A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.
B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

2.2 ACCESS PANELS AND ACCESS DOORS
A. Provide all access doors and panels to serve equipment under this work, including those which must be installed, in finished architectural surfaces. Frame of 16-gauge steel, door of 20 gauge steel. 1" flange width, continuous piano hinge, key operated, prime coated. Refer to Architectural Specifications for the required product Specification for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels is not shown on Plans. Access doors shall be of a size to permit removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted.
COMMON WORK RESULTS FOR ELECTRICAL

Provide access panel for each trap primer or concealed valve, for fire and combination fire/smoke dampers, and for volume dampers. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through. Provide cylinder lock for access door serving mixing or critical valves in public areas.

B. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to serve equipment under this work and in the proper sequence to keep in tune with construction and with prior approval of the Architect. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.

C. Acceptable Manufacturers: Milcor, Karp, Nystrom, or Elmdor/Stoneman.

D. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Architect.

2.3 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. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) 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.

2.4 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.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give way to piping systems installed at a required slope.

F. Equipment Dimensions: Provide equipment that fits the available space. Do not exceed dimensions indicated or shown without prior approval.

G. Field verify exact locations, dimensions, and routing of existing equipment.

H. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

I. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Architect.
3.2 MANUFACTURER’S DIRECTIONS

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

B. If the contractor must deviate from the manufacturer’s recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.3 INSTALLATION

A. Coordinate the work between the various Electrical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost. Coordinate wall and ceiling work with the General Contractor, and his subcontractors in locating lighting fixtures, wiring devices, disconnects, controllers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

3.4 ELECTRICAL REQUIREMENTS

A. Electrical Contractor shall coordinate with Division 23 work to provide electrical service as required to operate all mechanical devices under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer’s written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA’s “Standard of Installation” to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

C. Division 23 has responsibilities for electrically powered or controlled mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

1. Division 23 Mechanical Responsibilities:
   a. MOTORS: Furnish and install all motors necessary for mechanical equipment.
   b. MAGNETIC STARTERS: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
   c. VARIABLE FREQUENCY DRIVES: Provide all VFD’s associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
   d. DISCONNECTS: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
   e. CONTROLS: Division 23 Contractor (including the temperature controls subcontractor) is responsible for the following equipment in its entirety. This equipment includes but is not limited to the following:
      1) Control relays necessary for controlling Division 23 equipment
      2) Control transformers necessary for providing power to controls for Division 23 equipment
      3) Line voltage thermostats
      4) Low or non-load voltage control components
COMMON WORK RESULTS FOR ELECTRICAL

5) Remote bulb thermostats
6) Non-life safety related valve or damper actuators
7) Float switches
8) Solenoid valves, EP and PE switches
9) Refrigeration controls. (Division 26 provides power to refrigeration panels.)

f. FIRE AND LIFE SAFETY EQUIPMENT:
1) Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.
   a) Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with necessary end switches for proof of closure (see Section 233113.)
   b) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code (see Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.

2) Fire Sprinkler System: Division 23 is responsible for providing necessary controls including flow switches and alarm bells.

3) Specialized fire suppression systems: Division 23 is responsible for providing necessary system controls and any required control interface wiring to these controls. Division 26 is responsible for bringing power to point of connection with the system.

g. Division 26 has responsibilities for electrically powered or controlled mechanical equipment, which is specified in Division 23 Specifications or scheduled on Division 23 Drawings. The specific division of responsibilities between Division 23 and 26 for furnishing or wiring this equipment is as follows:

2. Division 26 Electrical Responsibilities:
   a. MOTORS: Provide the power wiring for the motors.
   b. MAGNETIC STARTERS: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters, Division 26 is to install the necessary power wiring to the starter.
   c. VARIABLE FREQUENCY DRIVES: Physically mount all VFD’s, which are not specified to be installed on Division 23 factory assembled equipment. Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD’s where wiring between the motor and VFD is to be by Division 23. Where disconnects are installed between a VFD and a motor provide the interlocking wiring between the disconnect and VFD to insure that the drive is shutdown simultaneously with motor.
   d. DISCONNECTS: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition provide power wiring between motor and disconnect when the disconnect is not factory installed. See also Variable Frequency Drive above for special wiring requirements.
   e. CONTROLS: Division 26 Contractor is responsible for providing power to control panels and control circuit outlets.
   f. FIRE AND LIFE SAFETY EQUIPMENT:
      1) Fire/Smoke Dampers: Division 26 is responsible for power wiring to the damper and as follows:
         c) Where these dampers are part of an integrated smoke control system Division 26 is responsible for providing the detectors and for all fire detection
COMMON WORK RESULTS FOR ELECTRICAL

System wiring necessary to integrate dampers and related end switches into the system.

d) Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code (see Section 233113). If not integral with the damper assembly, the detector is to be installed by Div. 23 but wired for damper control by Div. 26.

2) Fire Sprinkler System: Division 26 is responsible for providing power wiring to fire protection controls including flow switches and alarm bells.

3) Specialized fire suppression systems: Division 26 is responsible for providing power wiring to suppression system and power for controls.

3. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

4. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer’s written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

5. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that “cutting-over” has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

6. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

7. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid “ringing” copper conductors while skinning wire.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
COMMON WORK RESULTS FOR ELECTRICAL

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND 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. 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.

1.3 DEFINITIONS
A. EPDM: Ethylene-propylene-dieneterpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency.
C. Field quality-control test reports.

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.
B. Comply with NFPA 70.

1.6 COORDINATION
A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Cable Corporation.
   2. Southwire Company.
   3. Rome
   4. Anaconda-Erickson
   5. Okonite
   6. General electric
   7. Excell
B. Conductor Material:
   1. Copper complying with NEMA WC 5 or 7.
   2. Aluminum material not allowed.
C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
D. Multiconductor Cable: Armored cable, Type AC; Metal-clad cable, Type MC; Type SO. All multiconductor cables shall have full sized green insulated copper ground wire. Wiring methods without green ground wire are not approved as equal, special permission and approval by engineer is required. MC cable is not allowed for general use and is only allowed as approved by owner.
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

2.2 CONNECTORS AND SPLICES
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:
   1. 3M; Electrical Products Division.
   2. Buchanan
B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
C. Molded connectors with metal thread-on core shall be used for splicing 14, 12 and 10 wire.

2.3 WIRE PULLING LUBRICANT
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:
   1. Polywater
   2. Aqua Gel (clear)
   3. NO Ideal 77 Yellow

2.4 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:
   1. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.
C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATION
A. Feeders: Copper, stranded for No.14 AWG and larger.
   1. Solid copper conductors are not allowed.
B. Branch Circuit: Copper No.14 AWG and larger.
   1. Solid copper conductors are not allowed.
C. Aluminum conductors are not allowed.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
A. Service Entrance: Type THHN-THWN, single conductors in raceway.
B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
C. Feeders and Homeruns Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.
D. Feeders and Homeruns Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
E. Exposed Branch Circuits: Type THHN-THWN, single conductors in raceway.
F. Branch Circuits Concealed in Ceilings, Walls, Crawlspaces and Partitions: Type THHN-THWN, single conductors in raceway, Type MC and AC cables are not allowed in walls and not approved for homeruns to power panels.
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
H. Branch circuits to lighting and vibrating equipment: Type MC and AC.
I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conductors pulled shall not exceed 40% of conduit area.
B. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Oil and grease shall not be used to lubricate wires. Do not exceed manufacturer's recommended sidewall pressure values.
D. Do not exceed cable pulling tensions and bending radius as specified by the cable manufacturer.
E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Avoid kinking or abrasion to the insulation.
F. Couplings and conduit connectors shall have pre-insulated bushings in place before pulling wires.
G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
H. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
I. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.
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 methods and materials for grounding systems and equipment. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency and testing agency's field supervisor.
C. Field quality-control test reports.

1.4 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.
B. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
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.
C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS
A. Insulated Conductors: Comply with Division 26 "Low Voltage Electrical Power Conductors and Cables" unless otherwise required by applicable Code or authorities having jurisdiction.
B. Material: Copper.
C. Color: See specification section 26 0553 – Identification for electrical systems.
D. Equipment Grounding Conductors: Insulated with green-colored insulation.
E. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
F. Grounding Electrode Conductors: Stranded cable.
G. Bare Copper Conductors:
   2. Tinned Conductors: ASTM B 33.
H. Copper Bonding Conductors: As follows:
   1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
   2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
   3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with
GROUNDBING AND BONDING FOR ELECTRICAL SYSTEMS

copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

I. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated on drawings; 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. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch in diameter by 10 feet long.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors for No. 14 AWG and larger, unless otherwise indicated.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on drawings.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated. Bus to be 12 inches minimum in length unless noted otherwise on drawings.

F. Equipment Grounding Conductor Terminations use Bolted Pressure Clamps.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Metal-clad cable runs.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater and Heat-Tracing: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

E. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding conductor with branch-circuit conductors.

3.4 INSTALLATION

A. Equipment and Device Grounding
1. Equipment: Terminate ground conductor to equipment enclosure.
2. Receptacle: Terminate ground conductor to box and receptacle.

B. Grounding Conductors:
1. Route along shortest and straightest paths possible unless otherwise indicated or required by code. Avoid obstructing access or placing conductors where they may be subject to strain, impact or damage.

C. Ground Rods:
1. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor. Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate...
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building basement as indicated.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring.
2. Bury ground ring not less than 24 inches from building's foundation.

I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No.  4  AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
D. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

F. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

G. All connections and terminations are to be cad welded, crimped or compression type. Connections shall not be mechanically reversible.

3.6 FIELD QUALITY CONTROL

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.
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. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.
B. Related Sections include the following:
   1. Division 26 Section "Vibration and Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

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.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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.
   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.
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

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. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NEC 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Appleton
   b. Raco
   c. Thomas & Betts
   d. Kindorf
   e. Steel City
   f. Pline

E. 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.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used. All anchors shall have provisions for removal.
   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.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

H. Trapeze or wall surface supports shall be Kindorf “bolt-hole” base galvanized steel channels with C105 and C106 single bolt pipe straps.

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.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   6. To Light Steel: Sheet metal screws.
   7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

F. Hanger spacing
   1. Do not exceed 8’ on center.
   2. Provide a hanger adjacent to each outlet box.
   3. Provide one hanger within 12” on each side of a change in direction.

G. Conduits are not permitted to be supported from ductwork, pipes, t-bar ceiling supports or other systems foreign to electrical installation.

H. Support conduits as close to ceiling structure as practical.

I. Coordinate conduit locations with other trades.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION
PART 1 - GENERAL

1.1 RELATE CodecO 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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 07 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
   2. Division 26 Section "Hangers and Supports for Electrical Systems" and "Vibration and Seismic Controls for Electrical Systems" for seismic restraints and bracing of raceways, boxes, enclosures, and cabinets.
   3. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.

C. 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:
   1. Structural members in the paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal 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 cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified."
   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.

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.

B. Comply with NFPA 70.

C. Facilities maintenance electrician is to walkthrough the project with the electrical contractor to view pathways prior to encasement or enclosure.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Tube & Conduit; a Tyco International Ltd. Co.
   2. O-Z Gedney; a unit of General Signal.
   3. Triangle PWC Inc.
   4. Western Tube and Conduit

B. Rigid Steel Conduit: ANSI C80.1.
   1. Zinc coated by hot dip galvanizing or sherardizing.
   2. 3/4" size minimum.

C. EMT: ANSI C80.3.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

E. 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: set-screw or compression type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

F. 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.
   1. Fittings for EMT: Steel or set-screw or compression type.

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. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 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: Screw cover type.
E. Finish: Manufacturer's standard enamel finish.

2.4 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, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
   1. PVC sweeps and elbows are not allowed.

2.5 SURFACE RACEWAYS
A. Surface Metal Raceways: not allowed.
B. Surface Nonmetallic Raceways: not allowed.

2.6 BOXES, ENCLOSURES, AND CABINETS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hoffman.
   2. Circle AW.
   3. Rittal.
   4. Bell
   5. T&B
   6. Bowers
   7. Raco
   8. Steel City
   9. Or approved.
B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
C. Pressed steel Outlet and Device Boxes: NEMA OS 1.
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
E. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
F. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular. Refer to Section 26 2726 Wiring Devices.
G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and latch capable of being keyed to cat 15. Door in door panel doors.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
J. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 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. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. CDR Systems Corporation.
      d. Hubbell Quazite
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. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product 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.
      e. Hubbell Quazite

2.8 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard grey paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

SERA Architects, Inc.  Package 4 – 50% Construction Documents
PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit in areas where subject to damage; EMT in areas where not subject to damage.
2. Concealed Conduit, Aboveground: Rigid steel conduit, EMT.
4. Service Entrance: Rigid, Intermediate metallic or PVC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
7. No surface exposed PVC.
8. Application of Handholes and Boxes for Underground Wiring:
   a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete or Fiberglass enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
   b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units or Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
   c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiber-glass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
9. Utility Tunnels and Electrical Vault Conduit
   a. Conduit bodies shall not be used.
   b. Maintain a minimum of 6” clearance between conduit and mechanical piping.
   c. Maintain a minimum of 12” clearance between conduit and any heat source.
   d. Seal tunnel and vault penetrations with non-shrinking, vinyl reinforced, concrete sealant.

B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to a corrosive environment: EMT.
2. Exposed and Subject to Severe Physical Damage: IMC. Includes raceways in the following locations:
   a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   b. Mechanical rooms.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Galvanized rigid steel conduit or PVC 40
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

E. Do not install aluminum conduits in contact with concrete.

F. Flexible metal conduit is limited to the following applications:
1. Vibrating or moveable equipment connections.
2. Finished into existing stud walls.
3. Distance from the luminaire connection to structure to the powering junction box, not to exceed 6’.
### RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

#### 3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:
   1. Facilities maintenance electrician review and approval is required before any conduits are buried in slab.
   2. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   4. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, before rising above the floor.

I. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

J. Set floor boxes level and flush with finished floor surface.

K. Outlet boxes are to be sealed at exterior walls and as needed in other locations.

L. Outlet boxes are to be supported independent from the raceway system.

M. Electrical Boxes and Devices:
   1. Provide electrical boxes for electrical and low voltage devices. Mud rings only at TV, communication, data devices, etc., not allowed.
   2. Back-to-back electrical boxes are not allowed.
      a. Separate by at least one (1) stud cavity.
      b. Electrical boxes 24 inches apart: Apply mastic/putty pads on both outlets, seal airtight with non-hardening sealant.

N. Electrical boxes less than 24 inches apart: Apply mastic/putty pads on both outlets, plus both outlets boxed in. The box must be sealed airtight with non-hardening sealant and must use one layer 5/8 inch gypsum wall board.

O. Electrical Floor Boxes 24 inches apart: Apply mastic/putty pads on both outlets, seal airtight with non-hardening sealant.

P. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

Q. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used,
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

S. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

T. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where otherwise required by NFPA 70.

U. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

V. Surface Raceways: not to be installed.

W. Set floor boxes level and flush with finished floor surface.

X. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

Y. Maintain 12" clearance above removable ceiling tiles for all conduits.

Z. All conduit runs beginning at panels shall be no less than 3/4".

AA. All conduit runs are to run parallel to systems and/or walls, especially when encased in concrete.

BB. At conduit transitions from different temperatures seal the box and/or conduit.

CC. Conduit stub-ups to equipment shall be rigid steel extended a minimum of 12' outside building foundation and 5' outside outdoor concrete pads.

DD. All control boxes and panels are to have hinged covers with door-in-door panels.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

3.4 PROTECTION
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

B. At empty/un-used conduits, use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

3.5 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION
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. Wire basket cable trays.
   2. Ladder cable trays.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include data indicating dimensions and finishes for each type of cable tray indicated.
B. Shop Drawings: For each type of cable tray.
   2. Show fabrication and installation details of cable trays, 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.
C. Delegated-Design Submittal: For seismic restraints.
   1. 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. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
   2. Vertical and horizontal offsets and transitions.
   3. Clearances for access above and to side of cable trays.
   4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
B. Seismic Qualification Certificates: For cable trays, 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.
C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design cable tray supports and seismic bracing.
CABLE TRAYS FOR ELECTRICAL SYSTEMS

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
   2. Component Importance Factor: 1.0.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the floor plan drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-BASKET CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chatsworth
   3. Cablofil/Legrande.
   5. Cooper B-Line, Inc.

B. Description:
   1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
   4. Sizes:
      a. Straight sections shall be furnished in standard 118-inch lengths.
      b. Wire-Basket Depth: 4-inch usable loading depth by 12 inches, unless otherwise noted on drawings.
   5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
   6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 LADDER CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
2.5 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33, ASTM A1008/A1008M, Grade 33, Type 2.
2. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.

B. Finish:

1. Mill galvanized before fabrication.
2. Electrogalvanized before fabrication.
3. Hot-dip galvanized after fabrication.
   b. Hardware: Chromium-zinc plated, ASTM F1136, Stainless steel, Type 316.
   a. Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
   b. Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
   c. Epoxy-Resin Topcoat: Epoxy, cold-cured, gloss, MPI# 77.
CABLE TRAYS FOR ELECTRICAL SYSTEMS

8. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
9. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

B. Aluminum:
1. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
3. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

C. Stainless Steel:
1. Materials: Low-carbon, passivated, stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.
2. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.6 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
B. Covers: Solid, Louvered, Ventilated-hat, 2-in-3 pitch type made of same materials and with same finishes as cable tray.
C. Barrier Strips: Same materials and finishes as for cable tray.
D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.7 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. Comply with requirements for fasteners in Division 26 Section "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1, NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA FG 1, NEMA VE 2.
B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
D. Remove burrs and sharp edges from cable trays.
E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
F. Fasten cable tray supports to building structure and install seismic restraints.
CABLE TRAYS FOR ELECTRICAL SYSTEMS

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA FG 1, NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1, NEMA VE 2. Space connectors and set gaps according to applicable standard.

O. Make changes in direction and elevation using manufacturer's recommended fittings.

P. Make cable tray connections using manufacturer's recommended fittings.

Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07 Section "Penetration Firestopping."

R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

S. Install cable trays with enough workspace to permit access for installing cables.

T. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15000 V.

U. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

V. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems.

B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing
splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.
CABLE TRAYS FOR ELECTRICAL SYSTEMS

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION
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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
5. Silicone sealants.
B. Related Requirements:
1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Wall Sleeves:
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
F. Sleeves for Rectangular Openings:
2. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
   b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS
A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLELING

2. Sealing Elements: EPDM rubber 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.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS
A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Presealed Systems.

2.4 GROUT
A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS
A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION
3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS
A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section “Joint Sealants.”
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABELING

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION
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 Seismic Restraints for electrical equipment and systems.
B. Related Sections include the following:
   1. Division 26 Section "Hangers and Supports For Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

1.4 PERFORMANCE REQUIREMENTS
A. Refer to Structural Drawing S1.0 for design criteria.

1.5 SUBMITTALS
A. Product Data: For the following:
   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 agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For seismic-restraint details 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 static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
   2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
   3. Field-fabricated supports.
   4. Seismic-Restraint Details:
      a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
      c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

D. Retain paragraph below if procedures for welder certification are retained in "Quality Assurance" Article.

E. Welding certificates.

F. Qualification Data: For professional engineer.

G. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Loos & Co.; Seismic Earthquake Division.
   3. Mason Industries.

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: Reinforcing steel angle clamped 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.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Indicate type and quantity of restrained isolators described in first subparagraph below on Drawings or in the Electrical Vibration-Control and Seismic-Restraint Device Schedule on Drawings.

B. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

C. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

D. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 09 Section "Painting and Coatings" for related identification requirements.
   2. Division 26 Section "Basic Electrical Requirements."

C. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.2 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
   1. Equipment labels and signs
   2. Device labels
   3. Identification labeling for raceways, cables, and conductors
   4. Operational instruction signs
   5. Warning and caution signs
   6. Buried electrical line warnings

1.3 SUBMITTALS

A. None required.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

C. All labeling is to be reviewed and approved by the owner.

1.5 GRAPHIC SIGNAGE ALLOWANCE

A. Contractor shall put in their bid an allowance of $500.00 for purchasing additional graphic signage as deemed necessary by the Engineer. The design of the signage will be by the Engineer. The Contractor shall be responsible for obtaining the signs from an engraver and shall submit the purchase order to the contractor for payment. The contractor shall refund to the owner the unused portion of the allowance at the end of the job.

B. Permanent signage will be required, interior and exterior, at all utility boxes, vaults, manholes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Almetek
   2. American Labelmark Co.
   3. Brother’s Labels
   4. Calpico, Inc.
   5. Cole-Flex Corp.
   6. Emed Co., Inc.
   7. George-Ingraham Corp.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

8. Ideal Industries, Inc.
9. Kraftbilt
10. LEM Products, Inc.
11. Markal Corp.
13. Panduit Corp.
14. Radar Engineers Div., EPIC Corp.
15. Seton Name Plate Co.
17. W.H.Brady, Co.

2.2 CONDUCTOR AND CABLE IDENTIFICATION

A. Conductor Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, conductor markers with preprinted numbers and letters. Handwritten graphics are prohibited.

B. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50 deg F to 350 deg F. Provide ties in specified colors when used for color coding. For outdoor applications provide black UV resistant ties only; white ties are prohibited.

2.3 NAMEPLATES, LABELS, SIGNS, AND INSTRUCTION PLATES

A. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with Eyelet for fastener.

B. Aluminum-Faced Card Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inches thick, and laminated with moisture-resistant acrylic adhesive. Pre-print legend to suit the application, and punch for tie fastener.

C. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 inches by 2 inches by 19 gage.

D. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thickness for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. All exterior plates shall be punched for mechanical fasteners (pop rivets). Refer to details on drawings. Use Rowmark "Matt" for indoor use and Rowmark "Ultra-Matt" for exterior use. Nameplate lettering font shall be Helvetica, with bold or extra-bold strokes where indicated.

E. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

F. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.

G. Legend Plates: Die-stamped metal legend plate with mounting hole and positioning key for panel mounted operator devices, i.e. motor control pilot devices, hand-off-auto switches, reset buttons, etc. Stamped characters to be paint-filled.

H. Fasteners for Plastic-Laminated and Metal Signs:
   1. Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
   2. Aluminum pop rivets.

2.4 PANELBOARD, DISTRIBUTION AND MCC IDENTIFICATION

A. Circuit Numbering: Provide factory-supplied permanent self-adhesive labels to identify each pole of all panelboards.

B. Nameplates: Provide nameplates per above section: “Nameplates, Labels, Signs, and Instruction Plates.”
IDENTIFICATION FOR ELECTRICAL SYSTEMS

C. Schedule Holder: Provide crystal clear, heavy duty, 5 1/8” x 8 1/2” vinyl, long side open. Storesmart #STB897 peel and stick 8GA. Vinyl or approved equal.

2.5 DEVICE COVERPLATE LABELS

A. Coverplate material shall be as specified in Section 2627: Coverplates.
B. Embossed metallic or plastic tape (Dymo) is not acceptable for any application.
C. Methods of Inscription: (Unless otherwise noted)
   1. Self-adhesive Tape: For imprinted or thermal transfer characters onto permanent waterproof tape lettering system. (Brother’s or Kroy). Apply Matte finish spray coating (Krylon #1311) as required to make lettering waterproof.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Use numbers, lettering, and colors as approved in submittals and as required by code.
B. Sequence of Work: Where identification is to be applied to surfaces that requires finish, install identification after completion of finish work.
C. Installation:
   1. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
   2. Clean surface of dust, loose material, and oily films before applying identification.
   3. Install identification parallel to equipment lines.
   4. Apply using permanent methods and materials (such as tape and nameplate materials) that is suitable for the environment installed and will not degenerate over time due to UV, sunlight, humidity, temperature swings, etc.
   5. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment. Do not cover up other instructions or labels.

3.2 RACEWAY IDENTIFICATION

A. Identify Junction, Pull, and Connection Boxes:
   1. Identify junction, pull, and connection boxes above accessible ceilings, exposed in mechanical and electrical rooms and other non-finished areas such as tunnels, loading docks, etc., by neatly spray painting the box and cover plate the following colors: The boxes and covers shall be painted prior to installation. It is unacceptable to paint the boxes after installation where the overspray paints the conduits and other surrounding items. It is the Electrician’s responsibility to ensure that the boxes are not painted over by the architectural painting Contractor.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

a. Fire alarm system: Red with white label.
b. Emergency power or lighting: Red \{1\}.

2. Notes: \(1\) Label box covers with identity of contained circuits per the following convention: “Panel/MCC Name”-“Circuit Numbers.” Example: “HD1A-1,3,5.” Use Brother or Kroy Type labeling or neatly hand letter using block uppercase lettering and permanent type black marker. Engineer has right to require lettering to be redone if not done neatly.

3. In exposed public areas where the ceiling plane, structure, ductwork and conduits are to be painted an architectural color verify with Engineer the required methods for conduit and junction box identification.

3.3 CONDUCTOR AND CABLE IDENTIFICATION

A. Conductor Color Coding: Provide color coding for the following:

1. Secondary service, feeder, and branch circuit conductors throughout the project electrical system:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Phase</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>208 and 120 Volts</td>
<td>Black</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Blue</td>
<td>C</td>
</tr>
<tr>
<td>480 and 277 Volts</td>
<td>White*</td>
<td>Neutral</td>
</tr>
</tbody>
</table>

* neutrals in common raceways, provide color band/stripe on neutral that corresponds with phase conductor color

<table>
<thead>
<tr>
<th>Conductor Color Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
</tr>
<tr>
<td>Green w/ yellow stripe</td>
</tr>
<tr>
<td>Ground</td>
</tr>
<tr>
<td>Ground</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Purple</th>
<th>Traveler</th>
<th>Purple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink</td>
<td>Switch leg</td>
<td>Pink</td>
</tr>
</tbody>
</table>

2. Control wiring inside custom electrical equipment and control panels throughout the project electrical system, refer to mechanical specifications.

3. Use conductors with color factory-applied the entire length of the conductors except as follows:

a. The following field-applied color-coding methods may be used in lieu of factory-colored conductor for sizes larger than No. 10 AWG.

b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each conductor or cable at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

B. Future Connections: Tag or label conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.

C. Multiple Conductors/Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for color-coded, three-circuit, four-wire home runs) and wherever there is possible confusion in identifying each conductor, label each conductor or cable. Provide label indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be
IDENTIFICATION FOR ELECTRICAL SYSTEMS

Indicated by means of color-coded conductor insulation. For control and communications/signal wiring, use color coding or conductor/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on conductor/cable marking tapes. Conductor numbers shall match the manufacturer’s shop drawings.

D. Cable and Feeder Identification Tags: Securely fasten identifying tags around cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with stamped letters and numbers with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb test monofilament line or one-piece self-locking nylon cable ties.

3.4 NAMEPLATES, LABELS, SIGNS, AND INSTRUCTION PLATES

A. Apply warning, caution, and instruction signs and stencils as follows:
   1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
   2. Emergency Operating Signs: Install engraved, laminated signs with white text on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

B. Install equipment/system circuit/device identification as follows:
   1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless the factory supplied labeling on the unit is acceptable to the Engineer.
   2. Refer to drawings for details of signs, if details are not included provide the following minimum information:
      a. Equipment or device designation. (Minimum ¼” high)
      b. Amperage, KVA or horsepower rating, where applicable.
      c. Voltage or signal system name.
   3. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
      a. Panelboards, electrical cabinets, disconnects, and enclosures.
      b. Access doors and panels for concealed electrical items.
      c. All junction boxes and enclosures larger than 4” square.
      d. Each circuit breaker or fused switch in distribution boards, switchboards and switchgear.
      e. Electrical switchgear and switchboards.
      f. Electrical substations.
      g. Motor control centers.
      h. Motor starters.
      i. Pushbutton stations.
      j. Power transfer equipment.
      k. Contactors.
      l. Dimmers.
      m. Control devices.
      n. Transformers.
      o. Battery racks.
      p. Power generating units.
      q. Telephone switching equipment.
      r. Clock/program master equipment.
      s. Call system master station.
      t. TV/audio monitoring master station.
IDENTIFICATION FOR ELECTRICAL SYSTEMS

u. Fire alarm master station or control panel.
v. Security monitoring master station or control panel.
w. Spare conduits at both ends.

C. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, circuit breakers in distribution, switchboard and switchgear, lights, motor control centers, and similar items for power distribution, except panelboards and alarm/signal components, where labeling is specified elsewhere.

D. Provide legends on panel mounted operators devices such as pilot lights, reset buttons, hand-off-auto switches, pushbuttons and other control components.

3.5 Arc flash hazard labels

A. Arc flash labels shall be orange for PPE levels 0 through 4.

B. Arc flash labels shall be red for a dangerous hazard risk category.

C. The portion of the arc flash hazard label that contains the hazard risk category information shall be color coded as follows:

1. Hazard risk category 0: Green
2. Hazard risk category 1: Yellow
3. Hazard risk category 2: Tan
4. Hazard risk category 3: Orange
5. Hazard risk category 4: Pink
6. Hazard risk category 5: Red

D. Shall meet the requirements of NFPA & 2009 ANSI/NETA Standard for maintenance testing specifications: chapter 6, Power system studies.

E. See spec section 260573 – Over-current protection device coordination study and arc flash hazard analysis, for additional requirements.

3.6 PANELBOARD, DISTRIBUTION AND MCC IDENTIFICATION

A. Circuit Numbering: Starting at the top, odd numbered circuits in sequence down the left hand side and even numbered circuits down the right hand side.

B. Panelboard Nameplates: Mount nameplates with black Bakelite, white letters fastened with sheet metal screws. In finished public areas, such as in lobby or corridor walls, mount the nameplate to the top of the inside of the inner door then also provide an additional 0.75" high, single-line, white nameplate with black 1/4" high panelboard name. All nameplates that are to be mounted on the outside shall be centered, 1/2" up from the top on the inner door on the outside of the outer door.

C. Panelboard Schedule Holder: Mount schedule holder, secured to inside face of inner panel door. Contractor shall install construction panel schedules in holders during construction and replace with "as of record" panel schedules in holder at end of project. Final schedules shall include room numbers and explicit description and identification of items controlled by each individual breaker.

3.7 DEVICE COVERPLATE LABELS

A. Provide self-adhesive type labels for all receptacles, switches, outlets, plugmold, etc. per the following:

1. Lettering Type: Helvetica, 1/4" high.
2. Text: Label coverplates with identity of source and circuit number serving the device per the following convention: “Panel Name” - “Circuit Numbers” (except UPS circuits, which have word UPS as part of the label). Example: “MTE0032-1”, “UPS MTE0033-3”.
3. Color of Characters shall be as follows:

<table>
<thead>
<tr>
<th>Text Color</th>
<th>Background Color</th>
<th>System Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>White</td>
<td>Normal power devices coverplates</td>
</tr>
</tbody>
</table>

4. Installation of self-adhesive tape:
IDENTIFICATION FOR ELECTRICAL SYSTEMS

a. Imprinted tape shall be coated with a permanent, non-gloss protective finish. Spray coating shall be applied prior to installation or simultaneously as with Brother’s unit.
b. Tape shall be applied to coverplate there is no need to wrap label and label should be at bottom of plate. Top of plate for special equipment designations.
c. Inscription shall be centered and square with coverplate.

B. Provide engraved coverplates for switches, dimmers, etc. as follows: (in addition to panel-circuit number labels)
   1. All multi-ganged (three or more) switches or dimmers.
   2. All special purpose switches or controls, i.e. - fan, projector screen, etc. where it is not obvious what it controls.
   3. Engraving shall indicate fixtures or devices controlled (i.e. “Down Lights”, “Cove Lights”, etc.)

C. Switch cover platesthat control various systems (AV, projection screens, etc.) shall be labeled with 1/8” black lettering indicating the function.

3.8 GROUND CONDUCTOR

1. Label ground conductors at main ground bar.
2. No. 6 and larger are to be identified at accessible points per NEC.

END OF SECTION
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 computer-based, fault-current and overcurrent protective device coordination studies and arc flash hazard analysis. Protective devices shall be set based on results of the protective device coordination study.

1.3 SUBMITTALS
A. Product Data: For computer software program to be used for studies.
B. Product Certificates: For coordination-study and fault-current-study and arc flash hazard analysis computer software programs, certifying compliance with IEEE 399 and IEEE 1584.
C. Qualification Data: For coordination-study specialist. It is preferred that the gear manufacturer be responsible for coordination study. If this is not possible then written notification from the contractor needs to be provided to the engineer and a qualified engineer will be assigned to do the study.
D. Other Action Submittals: Provide preliminary coordination study for review with shop drawings for electrical gear package. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   4. Arc-flash hazard analysis.
E. Overcurrent protective device coordination study analysis report shall be provided by the manufacturer supplying the equipment.

1.4 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:
   1. 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.
   2. Professional engineer, licensed in the state where the project is located, shall be responsible for the study.
   3. All elements of the study shall be performed under the direct supervision and control of the 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 IEEE 1584 and NEC 70E for arc flash hazard analysis

PART 2 - PRODUCTS
2.1 COMPUTER SOFTWARE DEVELOPERS
A. Computer Software Developers: Subject to compliance with requirements, provide products by
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
AND ARC FLASH HAZARD ANALYSIS

one of the following:
1. SKM Systems Analysis, Inc.

B. The owner requires an electronic copy of the fault current study.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

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. Explicit negative sequence.
   b. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

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.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.

3. Available fault current at the primary terminals of the building transformer(s).

4. Electrical distribution system diagram showing the following:
   a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
   b. Circuit-breaker and fuse-current ratings and types.
   c. Relays and associated power and current transformer ratings and ratios.
   d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
   e. Generator kilovolt amperes, size, voltage, and source impedance.
   f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
   g. Busway ampacity and impedance.
   h. Motor horsepower and code letter designation according to NEMA MG 1.

5. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics; primary protective device, magnetic inrush current and overload capability.
3. OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS
  
  c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
  
  d. Time-current-characteristic curves of devices indicated to be coordinated.
  
  e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
  
  f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
  
  g. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
  
  h. Generator thermal-damage curve.
  
  i. Ratings, types and settings of utility’s over-current protective devices.
  
  j. Special over-current protective device settings or types stipulated by utility.

3.3 FAULT CURRENT STUDY
  
  A. Calculate the maximum available short-circuit in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
  
  1. Switchboard buses
  2. Medium-voltage buses
  3. Motor-control centers
  4. Distribution panelboards
  5. Branch circuit panelboards
  
  B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
  
  C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
  
  D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 424, and/or ANSI.
  
  1. Transformers:
     a. ANSI C57.12.22.
     b. IEEE C57.12.00.
     c. IEEE C57.96.
  
  
  
  4. Low-Voltage Fuses: IEEE C37.46.

  E. Study Report:
  
  1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

  F. Equipment Evaluation Report:
  
  1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  
  2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
  
  3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY
  
  A. Perform coordination study and prepare a written report using the results of fault-current study
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
AND ARC FLASH HAZARD ANALYSIS

and approved computer software program. Comply with IEEE 399.

1. Identify any deficiencies in the report.
2. Calculate the maximum and minimum ½-cycle short-circuit currents.
3. Calculate the maximum and minimum interrupting duty (5-cycles to 2-seconds) short-circuit currents.
4. Calculate the maximum and minimum ground-fault currents.
5. Coordinate down to 0.1 sec. (instantaneous) for normal systems
6. Coordinate down to 0.02 sec. for (instantaneous) for standby systems

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with IEEE 242 recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.
2. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
3. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company’s upstream devices. Instantaneous shall be shown coordinated down to 0.1 sec. for normal systems and down to 0.02 sec. for standby systems. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

SERA Architects, Inc.  Package 4 – 50% Construction Documents
3.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the NFPA70E-2004 annex D.

B. The flash protection boundary and incident energy shall be calculated at all significant locations in the electrical distribution system, (switchboards, switchgear, motor control centers panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated flash boundary considering an incident energy of 1.2 cal/cm².

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume the maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility where applicable.

G. The incident energy calculation must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
   1. Fault contribution from induction motor should not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals and the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute in incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2 where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

3.6 ARC FLASH WARNING LABELS
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS

A. Coordinate labels with U of O CPS department.

B. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in.x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed. No paper labels.

C. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated into the system.

D. The label shall include the following information, at a minimum:
   1. Location designation
   2. Nominal voltage
   3. Flash protection boundary
   4. Hazard risk category
   5. Incident energy
   6. Working distance
   7. Engineering report number, revision number and issue date

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on the recommended overcurrent device settings.
   1. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
   2. For each motor control center, one arc flash label shall be provided.
   3. For each low voltage switchboard, one arc flash label shall be provided.
   4. For each switchgear, one flash label shall be provided.
   5. For medium voltage switches one arc flash label shall be provided.

G. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

H. The overall color of the arc flash hazard label shall be orange for PPE levels 0 thru 4.

I. The overall color of the arc flash hazard label shall be red for a dangerous hazard risk category.

J. The portion of the arc flash hazard label that contains the hazard risk category information shall be color coded as follows: (Refer to the following sample arc flash hazard labels where the upstream over current protective device has no adjustable settings.)
   1. Hazard risk category 0: Green.
   2. Hazard risk category 1: Yellow.


5. Hazard risk category 4: Pink.
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS

![WARNING]

Arc Flash and Shock Hazard
Appropriate PPE Required

| 131 inches | Flash Hazard Boundary |
| 31         | cal/cm² Flash Hazard at 18 inches |
| Category 4 | Cotton Underwear + FR Shirt & Pant + Multi Layer Flash Suit |
| 208 VAC    | Shock Hazard when cover is removed |
| 00         | Glove Class |
| 42 inches  | Limited Approach |
| Avoid Contact | Restricted Approach |
| Avoid Contact | Prohibited Approach |
| Bus: CATEGORY 4 |

PROTECTIVE DEVICE: PD-0004

6. Dangerous: Red.

![DANGER]

NO SAFE PPE EXISTS
ENERGIZED WORK PROHIBITED

| 171 inches | Flash Hazard Boundary |
| 48         | cal/cm² Flash Hazard at 18 inches |

Dangerous! No FR Category Found

| 208 VAC    | Shock Hazard when cover is removed |
| 00         | Glove Class |
| 42 inches  | Limited Approach |
| Avoid Contact | Restricted Approach |
| Avoid Contact | Prohibited Approach |
| Bus: CATEGORY DANGEROUS |

PROTECTIVE DEVICE: PD-000D

END OF SECTION
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 lighting control devices:
      2. Time Switches.
      3. Outdoor and Indoor photoelectric switches.
      4. Standalone daylight-harvesting switching controls.
      5. Indoor occupancy sensors.
      7. Emergency shunt relays.
   B. Related Sections include the following:
      1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS
   A. LED: Light-emitting diode.
   B. PIR: Passive infrared.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show installation details for occupancy and light-level sensors.
      1. Interconnection diagrams showing field-installed wiring.
   C. Field quality-control test reports.
   D. Operation and Maintenance Data: For each type of product 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 ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE AUTOMATIC LIGHTING CONTROL SYSTEM
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      2. Lighting Control & Design, Inc.
      3. Lightolier Controls; a Genlyte Company.
      4. Lithonia Lighting; Acuity Lighting Group, Inc.
      5. Sensor Switch
6.  PCI
7.  Watt-Stopper
8.  Lutron

B.  Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

C.  Performance Requirements: Manual switches and an internal timing and control unit send a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

D.  Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.

1.  System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days’ duration.
2.  Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
3.  Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
4.  Astronomic Control: Automatic adjustment of dawn and dusk switching.
5.  Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
6.  Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.
7.  Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

E.  Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1.  Cabinet: Steel with hinged, locking door.
   a.  Barriers separate low-voltage and line-voltage components.
   b.  Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
   c.  Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2.  Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
   a.  Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
   c.  Endurance: 50,000 cycles at rated capacity.

F.  Push-Button Switches: Modular, momentary-contact, low-voltage type. Match color specified in Division 26 Section "Wiring Devices."
G. Digital Time Switches:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Watt Stopper (The) TS-400 or a comparable product by one of the following:
      a. Area Lighting Research, Inc.; Tyco Electronics
      b. Grasslin Controls Corporation; a GE Industrial Systems Company
      c. Intermatic, Inc.
      d. Leviton Mfg. Company Inc.
      e. Lightolier Controls; a Genlyte Company
      f. Lithonia Lighting; Acuity Lighting Group, Inc.
      g. Paragon Electric Co.; Invensys Climate Controls
      h. Square D; Schneider Electric
      i. TORK
      j. Touch-Plate, Inc.

2.2 TIME SWITCHES

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. Area Lighting Research, Inc.; Tyco Electronics
   2. Grasslin Controls Corporation; a GE Industrial Systems Company
   3. Intermatic, Inc.
   5. Lightolier Controls; a Genlyte Company
   6. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. Paragon Electric Co.; Invensys Climate Controls
   8. Square D; Schneider Electric
   9. TORK
   10. Touch-Plate, Inc.
   11. Watt Stopper (The)
   12. Lutron

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
   1. Contact Configuration: SPST.
   2. Contact Rating: 30-A inductive or resistive, 20-A ballast load.
   3. Programs: Channel quantity per schedule; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
   4. Astronomic Time: Selected channels.
   5. Battery Backup: For schedules and time clock.

2.3 OUTDOOR AND INDOOR PHOTOELECTRIC SWITCHES

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. Intermatic, Inc.
   2. Lithonia Lighting; Acuity Lighting Group, Inc.
   3. Novitas, Inc.
   4. Square D; Schneider Electric
   5. Sensor Switch, Inc.
   6. Watt Stopper (The)
   7. Lutron

B. Outdoor Photocell
   1. Description: Solid state, with SPS dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
LIGHTING CONTROL DEVICES

a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), 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.
b. Time Delay: 15-second minimum, to prevent false operation.
d. 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.

C. Indoor Photocell
1. Application:
   a. Provide closed loop type that measures total light level in the space for classrooms & labs.
   b. Provide open loop type for open 3 story space on eastern side of building.
2. Contact input photosensor.
   c. Input Voltage: 24V
   d. Output Voltage: 24V
   e. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required.
   f. Test mode override with LED status indicator.
   g. User adjustable parameters: on setpoint; off setpoint; and off setpoint time delay.
   h. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Analog photosensor
   a. Light level monitoring range 0-100FC.
   b. Input Voltage: 24V
   c. Output Voltage: 10V or as required per manufacturer.
   d. Programming is not integral to device but is made via system software.
   e. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required.
   f. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Combination Occupancy Sensor and Photocell
   a. As an option, a combination Occupancy Sensor and Photocell in place of the two separate devices where appropriate. Complete coverage and response must be obtained. Device must meet photocell and occupancy sensor device requirements listed in this section.

2.4 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries, Inc.
   2. Eaton Corporation.
   3. Hubbell Building Automation, Inc.
   5. Lithonia Lighting; Acuity Lighting Group, Inc.
   6. Sensor Switch, Inc.
   7. Watt Stopper.
   8. Lutron.

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:
LIGHTING CONTROL DEVICES

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
4. Power Pack: 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. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
11. Control Load Status: User selectable to confirm that load wiring is correct.
12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.5 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Sensor Switch, Inc.
6. Watt Stopper.
7. Lutron

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present (target level).
   b. When significant daylight is present.
2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.6 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Lighting
LIGHTING CONTROL DEVICES

3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. Sensor Switch, Inc.
6. Watt Stopper (The)
7. Lutron

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operation: Unless otherwise indicated, these should operate as vacancy sensors. When covered area is occupied, lights must be manually turned on, and will turn off automatically when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
   3. Isolated Relay Outputs: Sensor must have a set of contacts to report occupancy to HVAC.
   4. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   5. Indicator: Digital display, 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.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
   1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
   2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
   1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
   2. Areas listed in detection coverage subparagraphs below are typical.
   3. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   4. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   5. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
   6. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. 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.
LIGHTING CONTROL DEVICES

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.

F. Combination Occupancy Sensor and Photocell
1. As an option, a combination Occupancy Sensor and Photocell in place of the two separate devices where appropriate. Complete coverage and response must be obtained. Device must meet photocell and occupancy sensor device requirements listed in this section.

2.7 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bryant Electric; a Hubbell company.
   2. Cooper Industries, Inc.
   3. Hubbell Building Automation, Inc.
   5. Lightolier Controls.
   6. Lithonia Lighting; Acuity Lighting Group, Inc.
   7. Lutron Electronics Co., Inc.
   8. Sensor Switch, Inc.
   9. Square D; a brand of Schneider Electric.
   10. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:
   1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
   2. Sensing Technology: Dual technology - PIR and ultrasonic, unless otherwise indicated on drawings.
   3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
   4. Voltage: Match the circuit voltage 120 V or 277 V;
   5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
   7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.8 LIGHTING CONTACTORS

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. Hubbell Lighting
   2. Lithonia Lighting; Acuity Lighting Group, Inc.
   3. MicroLite Lighting Control Systems
   4. Sensor Switch
LIGHTING CONTROL DEVICES

5. Square D; Schneider Electric
6. TORK
7. Watt Stopper (The)
8. Lutron

B. Description: Electrically operated and electrically held, combination type with fusible switch, 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 scheduled, matching the NEMA type specified for the enclosure.

2.9 EMERGENCY SHUNT RELAY

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
   1. Lighting Control and Design, Inc.
   2. Wattstopper
   3. Sensor Switch

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: 277 V.

2.10 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. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

B. Power packs must be installed in an accessible location near the lighting it serves and not exposed to view from below. Locate over doorway where possible.

C. Occupancy Sensor Application: The following are guidelines for applying occupancy sensors devices for various types of areas unless otherwise specified on drawings or details. Refer to drawings for wall mount or ceiling mount application.
   1. PIR Wall Switch – Initial setting 15 minutes. Wattstopper PW-100 or equal
      a. Storage closets
      b. Small restrooms
      c. Janitor rooms
   2. Dual Technology Wall Switch – Initial setting 10 minutes and set initially as a vacancy sensor. Wattstopper DW-100 or equal.
LIGHTING CONTROL DEVICES

a. Small offices
3. PIR Ceiling Mount – Initial Setting 30 minutes. Wattstopper CI-300/355 or equal.
   a. Common building areas
   b. Lobbies
4. Dual Technology Vacancy sensor - Initial setting 15 minutes. Wattstopper LMRC-100 with LMDC-100 sensor, LMSW-102 switches and LMRL-100 relay interface. Or equal Sensor Switch Products.
   a. Small offices with fans.
5. Ultrasonic Ceiling Mount – Initial setting 15 minutes. Wattstopper UT-300/355 or equal.
   a. Stairways
6. Ultrasonic Ceiling Mount – Initial setting 15 minutes. Wattstopper WT-2250 or equal.
   a. Long Hallways
7. Dual Technology Ceiling Mount - Initial setting 10 minutes. Wattstopper DT-300/355 or equal.
   a. Large Restrooms
   b. Small Offices
   c. Large Offices
   d. Open Offices
8. Dual Technology Ceiling Mount - Initial setting 15 minutes. Wattstopper DT-300/355 or equal.
   a. Labs
   b. Large conference rooms
   c. Lunch Rooms/Hearth

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

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.
LIGHTING CONTROL DEVICES

3. After programming has been completed, presets shall be locked in to prevent inadvertent programming by staff.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION
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:
2. Integrated, multipreset modular dimming controls.

1.3 DEFINITIONS

A. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
B. 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.
C. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
D. SCR: Silicon-controlled rectifier.
E. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
1. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
2. Device plates and plate color and material.
B. Samples for Initial Selection: For master and remote-control stations, and faceplates with factory-applied color finishes and technical features.
C. Samples for Verification: For master and remote-control stations, and faceplates with factory-applied color finishes and technical features.

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.
B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:
1. Division 26 Section "Lighting Control Devices."
PART 2 - PRODUCTS

2.1 GENERAL DIMMING DEVICE REQUIREMENTS

A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.

B. Dimmers and Dimmer Modules: Comply with UL 508.
   1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
   2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

2.2 MANUAL MODULAR MULTISCENE DIMMING CONTROLS

A. Manufacturers: Provide products by the following:
   1. Lutron Electronics, Inc.

B. Description: Factory-fabricated equipment providing manual modular dimming control consisting of a wall-box-mounted, master-scene controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in one-, two-, or three-gang wall box under a single wall plate. Each zone station shall be adjustable to indicated number of scenes, which shall be recorded on the zone controller.

C. Operation: Automatically change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.

D. Each manual modular multiscene dimming controller shall include a master control and remote controls.

E. Each zone shall be configurable to control the following:
   1. Fluorescent lamps with electronic ballasts.
   2. Incandescent lamps.
   3. Low-voltage incandescent lamps.
   4. LED’s

F. Memory: Retain preset scenes through power failures for at least seven days.

G. Device Plates: Style, material, and color shall comply with Division 26 Section "Wiring Devices."

H. Master-Scene Controller: Suitable for mounting in a single flush wall box.
   1. Switches: Master off, group dim, group bright, and selectors for each scene.
   2. LED indicator lights, one associated with each scene switch, and one for the master off switch.

I. Fluorescent Zone Dimmer: Suitable for operating lighting fixtures and ballasts specified in Division 26 Section "Interior Lighting," and arranged to dim number of scenes indicated for the master-scene controller. Scene selection is at the master-scene controller for setting light levels of each zone associated with scene.
   1. Switch: [Rocker][Slider] style for setting the light level for each scene.
   2. LED indicator lights, one associated with each scene.
   3. Electrical Rating: [1000] [2000] VA, 120 V.

J. Incandescent Zone Dimmer: Suitable for operating incandescent lamps at line-voltage or low-voltage lamps connected to a transformer and arranged to dim number of scenes indicated for the master-scene controller. Scene selection shall be at the master-scene controller for setting light levels of each zone associated with scene.
   1. Switch: [Rocker][Slider] style for setting the light level for each scene.
   2. LED indicator lights, one associated with each scene.
3. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.

### 2.3 INTEGRATED, MULTIPRESET MODULAR DIMMING 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: Provide products by one of the following:

1. Lutron Electronics, Inc.

C. Indicate number of wall-box, remote-control stations.

D. Description: Factory-fabricated, microprocessor-based, solid-state controls providing manual dimming control consisting of a master station and multiple wall-box, remote-control stations.

E. Operation: Automatically changes variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.

F. Each zone shall be configurable to control the following:

1. Fluorescent lamps with electronic ballasts.
2. Incandescent lamps.
3. Low-voltage incandescent lamps.
4. LED's.

G. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.

H. Master Station:

1. Contains control panel and multiple control and dimmer modules.
2. Controls and commands adjustment of each dimmer-zone setting for each scene change from one preset scene to another.
   a. Master zone raises and lowers lighting level.
   b. Adjustable fade rate for each scene from 1 to 60 seconds.
3. Rear-illuminated, scene-select buttons.
4. Lighting-level setting and fade-rate setting shall be graphically shown using LEDs or backlighted bar-graph indicator.

I. Remote-Control Stations:

1. Numbered push buttons to select scenes.
2. Off switch to turn master station off.
3. On switch turns all scenes of master station to full bright.

J. Infrared Remote-Control Station: Same functions as for standard remote-control station, except that functions are input by a hand-held infrared transmitter.

K. Dimmers: Modular, plug-in type, with circuit breaker to protect the dimmer and branch circuit.

1. Dimming Circuit: Two SCR dimmers, in inverse parallel configuration.
2. Dimming Curve: Modified "square law" as specified in IESNA's "IESNA Lighting Handbook"; control voltage is 0- to 10-V dc.
3. Dimming Range: 0 to 100 percent, full output voltage not less than 98 percent of line voltage.
4. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.
5. Short-Circuit Rating: 10 kA for 120 V, 14 kA for 277 V.

### 2.4 CONDUCTORS AND CABLES
MODULAR DIMMING CONTROLS

A. 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. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. [18] [22] [24] AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" for identifying components and power and control wiring.

B. Label each dimmer module with a unique designation.

C. Label each scene control button with approved scene description.

3.3 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. Manufacturer's representative to notify owner when they will be on site and schedule a time for owner to walk through and coordinate settings of dimming control system. 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. Lighting controls contractor to contact owner post submittal for a 2 hour initial meeting to discuss install and setup. Manufacturer's representative and contractor to notify owner prior to programming and schedule a 1 hour meeting on site to coordinate setup of dimming control system. 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.

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. Continuity tests of circuits.

2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
MODULAR DIMMING CONTROLS

a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

b. After programming has been completed, presets shall be locked in to prevent inadvertent programming by staff.

D. Remove and replace malfunctioning modular dimming control components and retest as specified above.

E. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular dimming controls. Laptop portable computer shall be used in training.

B. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

END OF SECTION
SECTION 26 0943 - NETWORK LIGHTING CONTROLS

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 manually operated, PC-based, digital lighting controls with external signal source relays and control module.
B. Related Sections:
   1. Division 26 Section "Lighting Control Devices" for time clocks, photoelectric sensors, occupancy sensors, and multipole contactors.
   2. Division 26 Section "Modular Dimming Controls" for dimming control components.

1.3 DEFINITIONS
A. BACnet: A networking communication protocol that complies with ASHRAE 135.
B. BAS: Building automation system.
C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
D. 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.
E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
F. PC: Personal computer; sometimes plural as "PCs."
G. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
H. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.
I. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.
B. Shop Drawings: 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. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
   3. 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.
   4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
1.5 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
      1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
      2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
   B. Field quality-control reports.
   C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
   D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
   B. Software and Firmware Operational Documentation:
      1. Software operating and upgrade manuals.
      2. Program Software Backup: On a magnetic media or compact disc, or thumb drive, complete with data files.
      3. Device address list.
      4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Electrically Held Relays: Equal to 20 percent of amount installed for each size indicated, but no fewer than 4 relays.

1.8 QUALITY ASSURANCE
   A. Source Limitations: Obtain lighting control components through one source from a 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 47 CFR, Subparts A and B, for Class A digital devices.
   D. Comply with NFPA 70.

1.9 COORDINATION
   A. Coordinate lighting control components to form an integrated interconnection of compatible components.
      1. Match components and interconnections for optimum performance of lighting control functions.
      2. Coordinate lighting controls with BAS or HVAC controls. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
      3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.10 WARRANTY
   A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
NETWORK LIGHTING CONTROLS

1. Failures include, but are not limited to, the following:
   a. Failure of software input/output to execute switching or dimming commands.
   b. Failure of modular relays to operate under manual or software commands.
   c. Damage of electronic components due to transient voltage surges.

2. Warranty Period: Two years from date of Substantial Completion.

3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.

4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.11 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of the software.

1. Provide 30 days’ notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acuity Brands Lighting, Inc.; Lithonia Lighting brand.
   2. Acuity Brands Lighting, Inc.; Sensor Switch
   4. Lighting Control & Design, Inc.
   5. Lightolier Controls; a division of Genlyte Group, LLC.
   7. Watt Stopper/Legrand.
   8. Cooper Controls

2.2 SYSTEM REQUIREMENTS

A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based network-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

C. BAS Interface: Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports.
   1. Hardwired Points:
      b. Control: On-off operation.
   2. [ASHRAE 135 (BACnet)] [LonTalk] [Modbus] communication interface with the BAS shall enable the BAS operator to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

2.3 CONTROL MODULE
A. Control Module Description: Comply with UL 508 (CAN/CSA C22.2, No. 14); microprocessor-based, networked, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use.

1. Display: Single graphic display for programming lighting control panelboards.
2. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
3. Interoperability: Control module shall be configured to connect to [LonWorks] [BACnet] -compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.
4. Interoperability: Lighting control shall be configured to allow individual users to turn lighting on and off with their PCs. Software shall be written for Windows operating system, with Web page as the display and ActiveX controls that can be accessed through an Internet browser. Include at least three levels of password protection. Include an egress lighting option that will provide each user with a lighted path for exiting the building after normal working hours.
5. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days’ duration.
6. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
7. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
8. Astronomic Control: Automatic adjustment of dawn and dusk switching.
9. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.
10. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
   a. Software shall interpret status signals, provide for their display, and initiate failure signals.
   b. Lamp or LED at control module or display panel shall identify status of each controlled circuit.
11. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over [telephone lines] [data links]. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.
12. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
13. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.
14. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days’ minimum duration when power is off.

15. Programmed time signals shall change preset scenes and dimmer settings.

16. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.

17. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

18. Additional Programming: In addition to system programming by the PC, individual control modules shall be networked and programmable using data-entry and -retrieval (such as PCs, personal digital assistants (PDAs), hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs).

### 2.4 POWER DISTRIBUTION COMPONENTS

A. Modular Relay Panel: Comply with UL 508 (CAN/CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Cabinet: Steel with hinged, locking door.
   a. Barriers separate low-voltage and line-voltage components.
   b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
   c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
   a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
   c. Endurance: 50,000 cycles at rated capacity.

### 2.5 MANUAL ANALOG SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
   1. Match color specified in Division 26 Section "Wiring Devices."
   2. Integral green LED pilot light to indicate when circuit is on.
   3. Internal white LED locator light to illuminate when circuit is off.

B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."

C. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

### 2.6 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

A. Connection Type: RS-485 protocol, category 5e UTP cable, using RJ45 connectors. Power shall be from the control unit.

B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
   1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Division 26 Section "Wiring Devices."
   2. Multi-Gang Mounting: One to six pushbuttons per gang.

### 2.7 CONDUCTORS AND CABLES
NETWORK LIGHTING CONTROLS

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

E. RS-485 Cables:
   1. Standard Cable: NFPA 70, Type CM or CMG.
      a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
      b. PVC insulation.
      c. Unshielded.
      d. PVC jacket.
      e. Flame Resistance: Comply with UL 1581.
   2. Plenum-Rated Cable: NFPA 70, Type CMP.
      a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
      b. Fluorinated ethylene propylene insulation.
      c. Unshielded.
      d. Fluorinated ethylene propylene jacket.
      e. Flame Resistance: NFPA 262, Flame Test.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings. Minimum conduit size shall be 1/2 inch.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

F. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

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.
NETWORK LIGHTING CONTROLS

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. Test for circuit continuity.
   2. Verify that the control module features are operational.
   3. Check operation of local override controls.
   4. Test system diagnostics by simulating improper operation of several components selected by Architect.

E. Lighting controls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.3 SOFTWARE INSTALLATION

A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.4 ADJUSTING

A. 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.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. See Division 01 Section "Demonstration and Training."

B. A minimum of 1hr overview training for key building occupants regarding everyday use is required.

C. A minimum of 2hrs Facilities Maintenance Electrician training is required to maintenance and service level.

END OF SECTION
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 types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 SUBMITTALS
A. 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.
B. Shop Drawings:
C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, 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. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.
E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

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. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION
A. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.
PART 2 - PRODUCTS

LOW-VOLTAGE TRANSFORMERS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. General Electric Company.
   4. Federal Pacific
   5. Square D; a brand of Schneider Electric.

2.2 DISTRIBUTION TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service. 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: Grain-oriented, non-aging silicon steel. One leg per phase.

D. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper

E. Enclosure: Ventilated, NEMA 250, Type 2.


G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accord with NEMA TP2.

<table>
<thead>
<tr>
<th>kVA</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>97.0%</td>
</tr>
<tr>
<td>30</td>
<td>97.5%</td>
</tr>
<tr>
<td>45</td>
<td>97.7%</td>
</tr>
<tr>
<td>75</td>
<td>98.0%</td>
</tr>
<tr>
<td>112.5</td>
<td>98.2%</td>
</tr>
<tr>
<td>150</td>
<td>98.3%</td>
</tr>
<tr>
<td>225</td>
<td>98.5%</td>
</tr>
<tr>
<td>300</td>
<td>98.6%</td>
</tr>
<tr>
<td>500</td>
<td>98.7%</td>
</tr>
<tr>
<td>750</td>
<td>98.8%</td>
</tr>
</tbody>
</table>

K. 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:
LOW-VOLTAGE TRANSFORMERS

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.

L. Wall Brackets: Manufacturer's standard brackets.
M. Fungus Proofing: Permanent fungicidal treatment for coil and core.
N. 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.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
C. Provide neoprene waffle isolation pads selected for 0.25 inch deflection with neoprene washer/bushings where transformer is anchored to supporting structure or floor.

3.3 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 installation, including connections, and to assist in testing.
   2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
LOW-VOLTAGE TRANSFORMERS

4. Arc flash hazard analysis shall be performed to identify the shock hazard and appropriate personnel protective equipment (PPE) required at each transformer in accordance with the following standards:
   b. NFPA 70: National Electric Code
   c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

B. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

C. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.

D. Provide arc flash warning labels for all the equipment evaluated. Labels must be UV protected.

E. Studies shall use computer program software. Manual calculations are not acceptable.

3.4 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."

C. Tighten electrical connectors and terminals according to manufacturer’s published torque – tighten valves. If manufacturer’s torque valves are not indicated, use those specified in UL 486A and 486B.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION
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. 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

1.3 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Switchboards 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.”

1.4 SUBMITTALS
A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
B. Shop Drawings: For each switchboard and related equipment.
   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.
   2. Detail enclosure types for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   6. Detail utility company's metering provisions with indication of approval by utility company.
   7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   8. Include schematic and wiring diagrams for power, signal, and control wiring.
C. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, 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.
   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. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.
E. Operation and Maintenance Data: For switchboards 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:
SWITCHBOARDS

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 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. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
C. 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.
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 2.
F. Comply with NFPA 70.
G. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Handle and prepare switchboards for installation according to NECA 400 and NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.
   2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. General Electrical Company; GE Consumer & Industrial.

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   3. Sections front and rear aligned.

C. Nominal System Voltage: 480Y/277 V.

D. Main-Bus Continuous: As shown on the Drawings.

E. 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."

F. Indoor Enclosures: Steel, NEMA 250, Type 1.

G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

H. Utility Metering Compartment: Not required campus is primary metered by utility.

I. Power monitoring: See single line for power monitoring requirements. Refer to Electricity Metering specification section for additional information.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
   2. 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.
   3. 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.
   4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections.
   5. 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.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
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. No series rating.


3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time delay 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. Integrally 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).

B. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Compression style, 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 (HID) lighting circuits.


5. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

6. Power Monitoring: Integrated power monitoring in breakers that are capable of being connected to the Powerlogic Data Collection System.

2.3 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards and accessories according to NECA 400 and NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete Miscellaneous Cast-in-Place Concrete."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices and transient voltage suppression devices.
SWITCHBOARDS

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Torque logs are required at each service and/or distribution location to ensure good connections.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 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 installation, including connections, and to assist in testing.

2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.


4. Arc flash hazard analysis shall be performed to identify the shock hazard and appropriate personnel protective equipment (PPE) required at each switchboard in accordance with the following standards:
   b. NFPA 70: National Electric Code
   c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

B. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

C. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.

D. Provide arc flash warning labels for all the equipment evaluated. Labels must be UV protected.

E. Studies shall use computer program software. Manual calculations are not acceptable.

3.4 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION
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. Distribution panelboards
2. Lighting and appliance branch-circuit panelboards

1.3 DEFINITIONS
A. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Panelboards 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."

1.5 SUBMITTALS
A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include wiring diagrams for power, signal, and control wiring.
C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components serving life safety systems and equipment 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.
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. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
E. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.
   1. Arc Flash hazard analysis shall be performed to identify the shock hazard and appropriate personnel protective equipment (PPE) required at each switchboard, switchgear, distribution board, motor control center, panelboard, UPS, transformer, etc. in accordance with the following standards:
      c. NFPA 70E: Electrical safety requirements for employee workplaces.
   2. Provide written report and table summarizing the incident energy exposure available at every faulted bus.
   3. Provide arc flash warning labels for all the equipment evaluated.
   4. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides listed in the following. Manual calculations are not acceptable.
   5. Shall meet the requirements of 2009 ANSI/NETA Standard for maintenance testing specifications: Chapter 6, Power system studies.

F. Operation and Maintenance Data: For panelboards 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. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE
   A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories 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 PB 1.
   D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS
   A. Environmental Limitations:
      1. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
         a. Ambient Temperature: Not exceeding to plus 104 deg F (plus 40 deg C).

1.8 COORDINATION
   A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 EXTRA MATERIALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
PANELBOARDS

1. Keys: Six spares for each type of panelboard cabinet lock.

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. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

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. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper with 98 percent conductivity or aluminum.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Suitable for use copper and aluminum conductors.
   2. Main and Neutral Lugs: Mechanical screw lugs.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical screw lugs.
   4. Feed-Through Lugs: Mechanical screw lugs, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices. Provide a minimum of two extra and empty 3/4" conduit stubs at every new panel for future use.

F. Main breaker required at each panelboard.


2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. General Electrical Company; GE Consumer & Industrial.
   4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed for CAT 60 or CAT 70.
PANELBOARDS

D. Mains: Circuit breaker or Main Lugs only, refer to drawings.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

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.
   2. Siemens Energy & Automation, Inc.
   3. General Electrical Company; GE Consumer & Industrial.
   4. Square D; a brand of Schneider Electric.
   5. Cooper Bussman

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units. Where fused panelboards are used for selective coordination (emergency and standby branches), provide manufacturer’s integrated fusible switch device.

D. Doors: Door –in-door construction. Concealed hinges; inner door secured with flush latch with tumbler lock; outer door secured with screws, all panels keyed for CAT 60 or CAT 70.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Siemens Energy & Automation, Inc.
   3. General Electrical Company; GE Consumer & Industrial.
   4. Square D; a brand of Schneider Electric.
   5. Cooper-Bussman

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. No series rating.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable 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 i²t response.
   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. GFCl Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Common trip handle for circuits shown as multi-wire branch circuits on the drawings.
      c. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
C. Fused Switches:
1. Fused switches are only to be used where there is a coordination issue with using circuit breakers.
2. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
3. Device shall provide open fuse indication via permanently installed neon indicating light.
4. Device shall be UL and cUL Listed 600Vac, 200kA short-circuit current rating, load-break disconnect with amperage ratings and number of poles as indicated on the panelboard schedule.
5. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
6. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
7. No special tools shall be required for fuse removal.
8. Devices shall have bolt-on style bus connectors.
9. Device housing shall be clearly marked with device amperage.
10. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
11. Device shall provide fuse ampere rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, & 60A.
12. All overcurrent protective devices shall have a minimum interrupting rating of 300kA.
13. Branch circuit overcurrent protection shall be UL Listed 600Vac, minimum 300kA IR, IP20 finger-safe fuse with Class J performance characteristics.
14. Main overcurrent protective devices shall be UL Listed 600Vac, minimum 300kA IR, Class J time-delay fuses.
15. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.
B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
C. Mount top of trim 74 inches (2286 mm) above finished floor unless otherwise indicated.
D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
E. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
F. Install filler plates in unused spaces.
G. Comply with NECA 1.
H. Torque logs are required at each service and/or distribution location to ensure good connections.

3.2 FIELD QUALITY CONTROL
PANELBOARDS

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 installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
4. Arc flash hazard analysis shall be performed to identify the shock hazard and appropriate personnel protective equipment (PPE) required at each panelboard in accordance with the following standards:
   b. NFPA 70: National Electric Code
   c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

B. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

C. Arc flash hazard analysis report shall be provided by the manufacturer supplying the equipment.

D. Provide arc flash warning labels for all the equipment evaluated. Labels must be UV protected.

E. Studies shall use computer program software. Manual calculations are not acceptable.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 ADJUSTING

A. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

END OF SECTION
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 equipment for electricity metering by Owner.

1.3 DEFINITIONS
   A. PC: Personal computer.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: For electricity-metering equipment.
      1. Dimensioned plans and sections or elevation layouts.
      2. Wiring Diagrams: For power, signal, and control wiring. 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.

1.5 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
      1. Application and operating software documentation.
      2. Software licenses.
      3. Software service agreement.
      4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Receive, store, and handle modular meter center according to NECA 400.

1.9 PROJECT CONDITIONS
   A. 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 Architect, Construction Manager & Owner no fewer than two days in advance of proposed interruption of electrical service.
      2. Do not proceed with interruption of electrical service without written permission.

1.10 SOFTWARE SERVICE AGREEMENT
   A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
   B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion.
ELECTRICITY METERING

Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software. Contractor shall provide a site license for every meter.

1. Provide 30 days’ notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

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

1. Square D – Powerlogic
   a. Schneider Electric ION 7650 for service entrance switchboards.
   b. Square-D PM 850 with IO output cards at ATS. Normal power and switch position need to be monitored.
   c. Square-D PM 850 for PV system
   d. Square-D Advanced Intercept for all other sub-metering.
   e. Square-D Larger breakers with integrated power monitoring built-in and are capable of being connected to Powerlogic Data Collection system.

B. General Requirements for Owner’s Meters:

1. Comply with UL 1244.
2. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
3. Identification: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
4. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
5. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
6. Split-core sensor in first subparagraph below is installed in switchboard or panelboard without disturbing feeder connection but is less accurate. Solid-core sensor is usually installed in a separate compartment or in a separate current-transformer cabinet. Coordinate with Drawings.
8. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
9. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS 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. The smart meter head needs a modbus connection point to BMS.

C. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

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: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

D. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Division 26 Section "Control-Voltage Electrical Power Cables." Contractor to contact metering technician John Ahrends to verify proper installation of RS-45 cable.

E. Software: PC based, a product of meter manufacturer.
ELECTRICITY METERING

1. Activity Software: Automatically import energy-usage records to automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand. Prepare summary reports in user-defined formats and time intervals. Contractor to provide programming and licenses necessary for complete working system. Contact John Ahrends regarding programming and tying into UO system. All metering to be installed and functioning prior to main services being delivered to the building.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install modular meter center according to NECA 400 switchboard installation requirements.

C. Contractor to coordinate with mechanical contractor and commission power monitor system interface with BMS so all required points for M&V program are available and functioning.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

   1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
   2. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

3.3 FIELD QUALITY CONTROL

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.

   2. Verify that feeder has enough load to process accurate meter readings.

B. Tests and Inspections:

   1. Connect a load of known kilowatt rating, 1.5 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.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION
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. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Twist-locking receptacles.
   3. Floor service outlets.
   4. Switches, dimmers, occupancy sensors.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.
B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
C. AFCI: Arc fault current interrupter.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Samples: One for each type of device and wall plate specified, in each color specified.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate 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 NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers’ Names: Shortened versions (shown in parentheses) of the following manufacturers’ names are used in other Part 2 articles:
   2. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
   4. Wiremold Company (The)
   5. Lutron.
2.2 RECEPTACLES

A. Straight Blade Convenience Receptacles, heavy-duty specification grade, 5362 series, 125 V, 20 A, Plug Tail-Type: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A. Straight blade, non-feed-through to be used in all locations, Plug Tail-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.
   1. All receptacles located with weatherproof cover plates shall be classified in this category.

C. Twist-lock Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498 or Nema configuration as indicated on the drawings.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; L520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.

D. Isolated-Ground Receptacles: Straight blade, Heavy-Duty grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
   1. Devices: Listed and labeled as isolated-ground receptacles.
   2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

E. Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

F. Surface mounted outlet boxes shall be utilized only in conjunction with exposed conduits and shall be of the cast metal type with internal hubs and mounting flanges.

2.3 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.

2.4 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.

2.5 SWITCHES


B. Snap Switches: General-Duty grade, quiet type.

C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
   2. Receptacle: NEMA WD 6, Configuration 5-15R.
WIRING DEVICES

D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
   1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
   2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch wire connecting leads.
   3. 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.

E. Wallbox Occupancy Sensor: 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., option to choose Auto-ON or Manual-ON. Subject to compliance with requirements, provide one of the following:
   1. Watt Stopper (The); DW-100/DW-200.
   2. Hubbell;
   3. Leviton;

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. No plastic coverplates.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant with in-use protection and a lockable cover. All receptacles requiring a weatherproof cover plate shall be GFCI protected. These include but are not limited to the following:
   1. Outdoor areas

2.7 FLOOR SERVICE FITTINGS

A. Floor Box
   1. The floor box shall be manufactured from stamped steel and be approved for use on above grade floors. The box shall be fully adjustable, providing a maximum of 1 3/8" pre-pour adjustment, and a maximum of 3/4" after-pour adjustment. The box shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate workstation connectivity outlets and modular inserts, Wiremold RFB2 or RFB4 or as approved.

B. Activation Covers
   1. Activation covers shall be manufactured of die-cast aluminum or die-cast zinc, and be available in a brushed aluminum finish, plated brass finish, or a powder-coated paint finish. Finish to be verified with Architect for each area of facility. Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, flush covers, or covers with one 1" trade size screw plug opening and one combination 1 1/4" and 2" trade size screw plug openings for furniture feed applications.
   2. Flanged covers shall be Wiremold S38BBTCXX, S38CCTCXX or S38PPTCXX or as approved.
   3. Flangeless covers shall be Wiremold S39BBTCXX, S39CCTCXX or S39PPTCXX or as approved.
   4. The activation cover shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

C. Power Receptacle: NEMA WD 6 configuration 5-20R, finish by architect, unless otherwise indicated.
WIRING DEVICES

2.8 POKE-THROUGH ASSEMBLIES
A. 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: Flush type with two simplex receptacles and space for two RJ-45 jacks.
2. Size: Selected to fit nominal 3-inch 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 3-inch (75-mm) 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 two, 4-pair, Category 5 voice and data communication cables.

2.9 MULTIOUTLET ASSEMBLIES
A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
B. Raceway Material: Metal, with manufacturer's standard finish.
C. Wire: No. 12 AWG.

2.10 FINISHES
A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
3. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.
C. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtailed.
4. Existing Conductors:
a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtail existing conductors is permitted provided the outlet box is large enough.
D. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtail s that are not less than 6 inches (152 mm) in length.
   5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
   6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtailes for device connections.
   8. Tighten unused terminal screws on the device.
   9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
  10. Ground per specification section “Grounding and Bonding for Electrical Systems”

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Outlet boxes are to be sealed at exterior walls and as needed in other locations.

H. Outlet boxes shall be supported independent from the raceway system.

I. Dimmers:
   1. Install dimmers within terms of their listing.
   2. Verify that dimmers used for fan speed control are listed for that application.
   3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device listing conditions in the written instructions.

J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.

K. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section “Identification for Electrical Systems.”
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. 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.
WIRING DEVICES

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.

END OF SECTION
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. Cartridge fuses rated 600-V ac and less for use in enclosed switches and switchboards.
   2. Spare-fuse cabinets.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   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.

B. Operation and Maintenance Data: For fuses 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. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.

1.4 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 NFPA 70.

1.5 PROJECT CONDITIONS
A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION
A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.
1.7 EXTRA MATERIALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Fuses: Provide three (3) of each size used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Cooper Bussmann, Inc.
      2. Ferraz Shawmut, Inc.
      3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES
   A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET
   A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
      1. Size: Adequate for storage of spare fuses specified.
      2. Finish: Gray, baked enamel.
      3. Identification: "SPARE FUSES" in 1-1/2-inch high letters on exterior of door.
      4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
      5. Location: Mechanical and Electrical rooms with fused disconnects.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
   B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS
   A. Cartridge Fuses:
      1. Feeders: Class RK1, time delay.
      2. Motor Branch Circuits: Class RK5, time delay.
      3. Other Branch Circuits: Class RK5, time delay Class J, fast acting.

3.3 INSTALLATION
   A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION
   A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information including fuse type and size on inside door of each fused switch and adjacent to each fuse block, socket, and holder.
FUSES
END OF SECTION
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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. Section Includes:
   1. Fusible switches
   2. Nonfusible switches
   3. Shunt trip switches
   4. Molded-case circuit breakers (MCCBs)
   5. Enclosures

1.3 DEFINITIONS
A. NC: Normally closed
B. NO: Normally open
C. SPDT: Single pole, double throw

1.4 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 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."

1.5 SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   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. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.
C. Qualification Data: For qualified testing agency.
D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.
E. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than \(-22\) deg F and not exceeding \(104\) deg F.
   2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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.

B. Type HD, Heavy Duty, 600A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Limit the use of fused disconnect unless required by code or equipment manufacturer.

2.2 NONFUSIBLE SWITCHES

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.

B. Type HD, Heavy Duty, 600A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Provide auxiliary contacts to break contact to motor drives when used with motors.

2.3 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Littelfuse, Inc.
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

B. General Requirements: Comply with ASME A17.1, 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 transformer 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. Oiltight green ON pilot light.
   3. Isolated neutral lug; 200 percent rating.
   4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
   5. Form C alarm contacts that change state when switch is tripped.
   6. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
   7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.4 MOLDED-CASE CIRCUIT BREAKERS

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.

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. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

G. 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. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

6. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.

2.5 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.
   6. Hazardous Areas if Indicated on Drawings: NEMA 250, Type 7 or Type 9.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in fusible devices and provide spare fuses for each fusible device.
E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

END OF SECTION
PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS
A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 260500 - Basic Materials and Methods, and other Sections in Division 26 specified herein.

1.2 SCOPE
A. Furnish complete and operational VFD systems as shown on the plans. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:
   1. Variable frequency drives (VFDs)
   2. Controls and control connections
   3. Electrical power connections

1.3 RELATED WORK IN OTHER SECTIONS
A. Section 230500: Basic Materials and Methods
B. Section 230593: Testing, Adjusting and Balancing
C. Section 230900: Controls and Instrumentation
D. Section 232123: Pumps and Hydronic Specialties
E. Section 237315: Dedicated Outside Air Handling Units
F. Division 26: Coordination of interface items between the Mechanical equipment and controls and the Electrical Work specified in Division 26.

1.4 QUALITY ASSURANCE
A. Supplier of VFD shall be solely responsible for assuring that the VFD shall work properly with the motor(s) being controlled. VFD supplier shall provide all materials and labor required to replace motors, bearing, shafts, etc. that may be incompatible with VFD or become damaged by VFD at no additional cost to the owner. VFD supplier shall reimburse Architect and Engineer at their standard hourly rates for their involvement in resolving failures due to their VFDs.
B. Manufacturer shall have a minimum of 15 years experience building similar equipment for controlling the speed for induction motors and at least one hundred successful installations with a variety of VFD sizes and applications.
C. To insure quality and minimize failures the VFD(s) and connected motor(s) shall be by one manufacturer. To reduce the known problem of bearing failures by "fluting" the VFD switching rates shall be 6-8 Khz wherever possible. Manufactured VFDs at switching rates of 12-15 Khz shall be accompanied by an additional extended warranty to cover bearings and motors to a period of ten (10) years. Should it be impossible to provide matched motor and VFD’s provide a shaft grounding system for the driven motor. Acceptable manufacturer is Shaft Grounding Systems in Albany, Oregon (Representative: DP&A Sales 541-997-4068) or Aegis Shaft Grounding Ring (www.est-aegis.com/cse).
D. To insure quality and minimize infantile failures at the job site, the VFD shall be burned in at the factory at an ambient of 104°F minimum for at least 8 hours. The VFD shall be operating a dynamometer and the load speed shall be cycled during the test. All optional and special features shall be functionally tested at the factory for proper operation.
E. Codes and Standards: Provide VFDs conforming to the requirements of the latest addition of the following:
   1. ANSI/EIA 508 Electrical Performance Standards for Television Broadcast Transmitters
   2. UL508C. all VFD equipment provided under this section must be labeled as UL508C approved.
VARIABLE FREQUENCY DRIVES (VFD)

5. Motors, MG1 parts 30 & 31.
7. IEC 16800 Parts 1 and 2

1.5 QUALIFICATIONS

A. VFD and options shall be UL listed as a complete assembly. VFD requiring customer supply of external fuses for the VFD to be UL listed is NOT acceptable.
B. The base VFD shall be UL listed for 100 KAIC without the need for input circuit breaker.
C. CE Mark: The VFD shall conform to the European Union Electro Magnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level to ensure the VFD does not emit radiated interference.

1.6 SUBMITTALS

A. Concurrent Facilities review and approval of construction submittals required.
B. Product data on variable frequency drives and related components indicating all features specified.
C. Start up log/check list showing successful operation.
D. Operation and Maintenance data
E. Prior to construction submit for approval the following materials:
   1. VFD supplier shall provide reference list showing at least ten years of prior manufacturing experience in production of VFDs and a list of at least twenty successful installations with a variety of VFD sizes and applications.
   2. Manufacturer's data, installation instructions, and maintenance and operational instructions for variable frequency drives. Indicate electrical service and special requirements. Include manufacturer's descriptive literature, repair data, and parts listing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer's stamp or label affixed.
B. Protect units against dirt, water, chemical, and mechanical damage. Do not install damaged units. Remove damaged equipment from site.

1.8 WARRANTY

A. Warranty shall be 24 months from the date of certified start-up.
B. Warranty shall include all parts, labor, travel time, software, software updates, and access tools at no additional cost to the Owner.
C. 24 hour support line shall be available on a toll-free line.

1.9 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. 24 hour technical support line shall be available on a toll-free line.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
VARIABLE FREQUENCY DRIVES (VFD)

A. Acceptable Manufacturer: ABB unless reviewed and approved by Facilities Maintenance via Construction Standards Substitution Request.
   1. NO third party VFD.
   2. NO ‘brand labeled’ VFD.
   3. NO packaged VFD.
   4. Any substitution must comply with requirements listed below.
   5. It is required that the drive manufacturer have an existing sales representative exclusively for HVAC products, with expertise in HVAC systems and controls as well as an independent service organization.
   6. The drive manufacturer shall supply the drive and all necessary controls as listed below.
   7. The manufacturer shall have been in the production of this type of equipment for a minimum of 20 years.

2.2 GENERAL

A. Furnish a complete VFD as scheduled on the plans. Refer to plans for locations of variable speed controllers. Each fan or pump motor shall have a dedicated VFD unit. All standard and optional features shall be included within the VFD enclosure unless otherwise specified. The VFD enclosure shall be provided to match the environment requirements where the VFD will be mounted and operated. Provide NEMA rated enclosure as required. Provide type 1 NEMA VFD’s wherever possible. NEMA 12 VFD’s must be provided if the VFD is to be run during construction other than testing or the contractor must have the VFD cleaned by a factory tech. Provide type 12 enclosures where located directly below piping or water source.

B. Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

C. VFD to be dedicated variable torque design for specific use with centrifugal loads.

D. Provide completely solid state variable frequency power and logic unit.

E. Speed control to be step-less throughout the range under variable torque load on continuous basis.

F. VFD is to be controlled by DDC.

G. Provide adjustable frequency control with diode bridge/capacity input designed to provide high, constant power factor of 0.95 regardless of load or speed and eliminate SCR line noise.

H. Control shall be suitable for operation in ambient temperatures of 0 to 40 degrees C.

I. VFD shall be factory tested with an AC induction motor 100% loaded and temperature cycled within an environmental chamber at 104°F.

J. VFD drives are to be proofed through user adjustable drive auxiliary output.

K. Drives and motors must be compatible.

2.3 SELF PROTECTION AND RELIABILITY FEATURES

A. Adjustable current limit on drive to motor maximum amps.

B. Adjustable instantaneous over-current trip

C. Under voltage trip

D. Over temperature trip

E. Short circuit protection phase to phase and phase to ground faults phase rotation insensitive

F. Momentary power loss, more than 17 milliseconds

G. Transient protection against all normal transients and surges in incoming power line

H. Orderly shutdown in event of any of above conditions, drive shall be designed to shut down safely without component failure.
VARIABLE FREQUENCY DRIVES (VFD)

I. Provide visual indication and manual reset

2.4 FEATURES

A. Drive logic shall be microprocessor based. Control logic shall be isolated from power circuitry

B. The free standing VFD assembly shall have a circuit breaker disconnect and be UL 508C listed for use on distribution systems with 22,000 AIC.

C. Minimum user adjustable inputs and outputs:
   1. 2 independent analog outputs
   2. 3 digital outputs
   3. 6 digital inputs
   4. ALL are to be independent of the VFD function.

D. Frequency Stability: Output frequency will be held to +0.1% of maximum frequency regardless of load, +10% input voltage change or temperature changes within ambient specification.

E. Built-in digital display on the panel face shall be capable of indicating output frequency, voltage and current and shall provide indication of over current, over voltage, current limit, ground fault, over temperature, input power on, minimum or maximum speed adjustment, power on, fault condition.

F. Start and stop control

G. If applicable, the control circuit transformer will have primary and secondary fusing.

H. Minimum and maximum speed control

I. Adjustable acceleration and deceleration; independently adjustable 10-100 second.

J. Hand-Off auto switch(s)

K. Programmable Auto Restart after power outage.

L. The following disconnect switching is required at a minimum:
   1. Safety Disconnect: Does not need to be fused. Shall include an early break auxiliary contact to disable the drive when in the ‘Off’ position.
   2. Service Switch: To be mounted at the ‘Safety Disconnect’ for an orderly shut-down on control. A label shall be included to read ‘NOT an Emergency Shut-Down for VFD’.

M. Remote contacts for fault, and on/off status.

N. Adjustable motor output voltage.

O. Analog output voltage of 0-10 VDC, 4-20 MA proportional to control output frequency.

P. Manual speed control for each motor.

Q. UL listed enclosure is to be completely assembled and tested in an ISO9001 manufacturing facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

R. Provide output filters for all VFD locations more than 25 conductor feet from the motor they serve. Output reactors shall permit VFD to be located up to 350ft from the motors they serve.

S. The VFD shall have an integral 5% impedance line reactor to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD with only one DC reactor shall add AC line reactors. This increased impedance lower harmonic distortion (Vthd) meeting IEEE-519 guidelines.

T. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV (phase to phase and phase to ground), a capacitor clamp and 5% impedance reactors. MOV to protect against transients that would trip a VFD off line or cause serious damage.

U. VFD shall have the following adjustments:
VARIABLE FREQUENCY DRIVES (VFD)

1. A minimum of 2 PID set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.

2. The VFD shall have 250 ma of 24 VDC (minimum) auxiliary power and be capable of loop powering a transmitter supplied by others.

3. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus.

4. There shall be at least two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer and winter set points, etc.

5. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain set point of an independent process (i.e. valve, dampers, etc.).

6. All set points, process variables, etc. are to be accessible from the serial communications network.

7. The set points shall be set in engineering units and not require a percentage of the transducer input.

8. Allows complete control of a system or process

V. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. ‘Override Mode’ shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

W. All VFD shall have EMI / RFI filters. The onboard filters shall allow the VFD assembly to be CE marked and the VFD shall meet product standard EN 61800-3 for the first environment restricted level, and exceed FCC guidelines with motor cables less than 100 feet.

X. All VFD through 50HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. Prevents damage to the VFD when the electrical contractor wires the input power to motor terminals.

Y. The VFD shall catch a spinning load in forward and reverse direction

Z. Serial Communications:

1. The VFD shall have an RS-485 port as standard. The standard protocol shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority. Use of non-certified protocols is not allowed.

2. The VFD shall allow the DDC to control and monitor the drive’s digital and analog outputs via the serial interface. This control shall be independent of any other VFD function.

3. The VFD shall include an independent PID loop for customer use. This independent PID loop may be used for cooling tower bypass valve control, chilled water valve control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set point command and last good DO & AO commands in memory in the event the connection is lost.

4. Serial communication:
   a. Capabilities shall include, but not be limited to: run-stop control; speed set adjustment; proportional/integral/derivative PID control adjustments; current limit; acceleration and deceleration time adjustments; and lock and unlock the keypad.
   b. The drive shall have the capability of allowing the DDC to monitor feedback such as: process variable feedback; output speed/frequency; current (in amps); percent torque; power (kW); kilowatt hours, with the ability to reset; operating hours, with the ability to reset; drive temperature.
VARIABLE FREQUENCY DRIVES (VFD)

c. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and output values.
d. All diagnostic warning and fault information shall be transmitted over the serial communications bus.
e. Remote VFD fault reset shall be possible.
f. The following additional status indications and settings shall be transmitted over the serial communications bus: keypad ‘Hand’ or ‘Auto’ selected; bypass selected; the ability to change the PID set point; the ability to force the unit to bypass, IF bypass is specified.
g. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode, IF bypass is specified.

AA. OPTIONAL FEATURES: Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL listed by the drive manufacturer as a complete assembly and carry a UL508 label.

1. A complete factory wired and tested bypass system consisting of an output contactor and a bypass contactor. Overload protection and shall be provided in both drive and bypass modes.
2. Door interlocked, and pad-lockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.
3. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.
4. The drive bypass shall provide single-phase motor protection in both the VFD and bypass modes.
5. The following operators shall be provided:
   b. Drive mode selector.
   c. Bypass mode selector.
   d. Bypass fault reset.
6. The following indicating lights (LED type) shall be provided and a test mode or push to test feature shall be provided:
   a. Power-on (Ready).
   b. Run enable (safeties) open.
   c. Drive mode select damper opening.
   d. Bypass mode selected.
   e. Drive running.
   f. Bypass running.
   g. Drive fault.
   h. Bypass fault.
   i. Bypass H-O-A mode.
   j. Automatic transfer to bypass selected.
   k. Safety open.
   l. Damper opening.
   m. Damper end-switch made.
7. The following relay (form C) outputs from the bypass shall be provided:
   a. System started.
   b. System running.
   c. Bypass override enabled.
   d. Drive fault.
   e. Bypass fault (motor overload or underload, broken belt).
VARIABLE FREQUENCY DRIVES (VFD)

8. The digital outputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.

9. Customer Interlock Terminal strip. Provide a separate terminal strip for connection to freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override). The remote start/stop contact shall operate in VFD and bypass modes.

10. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman’s override. Two modes of operation are required:
   a. One mode forced the motor to bypass operation and overrides both the VFD and bypass HO-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
   b. The second fireman’s override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).

11. The VFD shall include a ‘run permissive circuit’ that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve and-switch. When the VFD system safety interlock (fire detector, freeze-stat, high static pressure switch, etc.) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

12. Class 20 or 30 (selectable) electronic motor overload protection shall be included.

13. There shall be an internal switch to select manual or automatic bypass.

14. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

PART 3 - EXECUTION

3.1 INSTALLATION

A. VFD shall be installed in accordance with applicable codes and manufacturer’s written installation instructions.

B. Install on a strut support system

C. VFD not to be mounted inside motor control centers or fan units

D. Each VFD will operate only one motor

E. Verify that mounting surface is ready to receive work. Mount the VFD(s) on the wall or at supports in locations identified on the drawings. Provide a layout drawing of VFD locations to electrical installer.

F. If the disconnect for the equipment powered by the VFD is in a location where it is probable that it will be placed in an off position prior to shutting down the VFD, the contractor is to provide electrical protection for the VFD. This may be in the form of a conduit and wire interlock between disconnect and drive or internal protection integral to the VFD.

G. Coordinate wiring and control with Control Contractor. Control installers shall install all wiring associated with control signals into the VFD and for interlock control wiring between disconnects and VFDs.

H. Electrical installer shall install all line voltage power wiring and conduit from electrical switchgear and from the VFD to the disconnect at the controlled motor. The only exception to this is when the motor and drive are factory installed on a packaged piece of equipment. In that case the wiring from drive to motor is to be installed in the factory to meet the requirements herein. Coordinate with Division 26 work.
VARIABLE FREQUENCY DRIVES (VFD)

I. Line length between VFD and driven motor shall be as short as possible. Line length shall not exceed twenty (20) feet without prior approval from Engineer.

J. Input and output power wiring shall be installed in separate grounded conduit. In addition, control wiring shall be installed in its own separate grounded conduit.

K. Use symmetric motor cable between the VFD and motor, with low inductance shield or conduit, and with all joints joined with bonding straps. MC metal clad 3 phase type cable per NEC 334-1, UL approved, 3 phase conductors and 3 ground conductors. Sheath to be continuous corrugated aluminum. Manufacturer and type to be BICC 2 kV rated Drives Cable, Anixter series 7V, or approved equal.

L. Use cable connectors with 360 degree connections to the armor conduit at both ends of motor cable. Verify electrical path from inverter cabinet entry plate to armor / conduit to motor terminal box.

M. Install an auxiliary high frequency bonding connection for potential equalization between VFD frame and building steel.

N. Unless absolutely necessary do not install disconnect between VFD and connected motor. VFD is to be furnished with a lockable disconnect.

3.2 HARMONIC MEASUREMENT

A. Perform harmonic measurement at the point where the utility feeds multiple loads (PCC) to verify compliance with the latest version of IEEE 519-1992.

B. Provide a report of the voltage THD and current TDD for Engineer and Facilities Maintenance review prior to substantial completion.

C. Provide labor, materials, and protection as needed to access the test points.

D. The readings shall be taken with all drives and other loads at full load, or as close to this as field conditions allow.

3.3 FIELD QUALITY CONTROL

A. Prior to installation, manufacturer’s representative shall coordinate VFD control interface with the control contractor and verify the intended installation (controls, wiring, etc.) complies with the manufacturer’s recommendations.

B. Field Test: Except where initial VFD operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests shall be performed by the manufacturer’s representative in the presence of the Facilities PM and/or Maintenance Electrician.

3.4 MANUFACTURER’S START-UP SERVICES

A. Comply with manufacturer’s instructions for startup.

B. Start up shall be provided under the direct supervision of the manufacturer’s representative and factory trained personnel.

C. Certified factory start-up shall be provided for each drive by a factory authorized service center.

D. A certified start-up form shall be filled out for each drive with a copy provided to the Facilities PM, and a copy kept on file at the manufacturer.

E. The manufacturer shall provide start-up service in the form of a factory trained service technician. The service technician shall verify correct installation, verify control wiring, verify power wiring, start-up the drive, and check for proper operation. The service technician shall provide final adjustments to meet the specified performance requirements. Fully staffed parts and service personnel shall be within four hours travel from the jobsite.

F. Carrier Frequency Set-up:

1. Set initial carrier frequency at 2 kHz.
VARIABLE FREQUENCY DRIVES (VFD)

2. Manually raise VFD speed output from 10 Hz to 60 Hz by 10 Hz increments, allowing at least 15 seconds between each adjustment. If excessive motor noise is heard at any speed, raise carrier frequency by 2 kHz increments until motor noise is no longer excessive. Do not set carrier frequency higher than 10 kHz.

3. If excessive motor noise continues to be heard at or below 10 kHz, inform owner. If the motor is provided by the VFD manufacturer, either repair, replace, or provide 5 year extended warranty on the effected motor.

G. Lockout of resonant frequencies:

1. With carrier frequency set per the above specification, manually and slowly raise VFD speed output from 10 Hz to 60 Hz by 1 Hz increments. If excessive motor, frame, or driven load noise is heard at any speed, lock out that frequency.

2. Each frequency skip shall be programmed with as narrow a bandwidth as possible, while still avoiding the most objectionable range of resonant frequencies. Each frequency skip bandwidth shall not exceed 5 Hz without approval by Engineer.

H. Training:

1. Provide 1 hour training session to the owner’s representative.

2. Training to include:
   a. Demonstration of operation of bypass switch and door-mounted disconnect switches. Explain emergency operation.
   b. Demonstrate operation of operator keypads for viewing data and setting parameters.
   c. Demonstrate operation in manual mode, including setting of specific speeds.
   d. Explain the drive parameters that might require operator adjustment.
   e. Describe troubleshooting techniques and warranty procedure.

END OF SECTION
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 transfer switches rated 600 V and less, including the following:
      1. Automatic transfer switches.
      2. Remote annunciation systems.

1.3 SUBMITTALS
   A. Provide compliance letter for requirements identified in each sub section of this Specification and Construction Drawing Details. All compliance and deviations shall be identified. Letter shall be at the front of the submittal. Also require them to provide a Bill Of Material in the submittal. Standard cut sheets and arrows are hard to sort through and take time. Verify there is a warranty section for the generator and associated components. The checklist will cover what gets a warranty however the time frame is part of the individual sections.
   B. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
   C. 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.
   D. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches 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."
   E. Operation and Maintenance Data: For each type of product 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. Features and operating sequences, both automatic and manual.
      2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 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 eight hours from time of notification.
   B. Source Limitations: Obtain automatic transfer switches 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.
TRANSFER SWITCHES

D. Comply with NEMA ICS 1.
E. Comply with NFPA 70.
F. Comply with NFPA 110.
G. Comply with UL 1008.

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 SEISMIC CONSIDERATIONS
A. The ATS assembly shall be suitable for and certified to meet all applicable seismic requirements of the project site. Guidelines for the installation consistent with these requirements shall be provided by the ATS manufacturer and be based upon testing of representative equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Asco
   b. GE Zenith
   c. Square D
   d. Russell

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. Capable of switching all classes of load and shall be rated for continuous duty when installed in non-ventilated enclosures.
C. Full load current rating at 208Y/120 volts, 480/277, 3-phase, 4-wire, 60 Hertz AC normal and emergency.
D. 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.
   1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
E. 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.
F. 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.
G. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
TRANSFER SWITCHES

3. 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.

I. The switch shall be 4-pole switched neutral type with all poles on a common shaft, so neutral pole is switched simultaneously with phase poles.

J. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

K. 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.

L. Coordinated switch status through power monitoring system.

M. 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.

N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

O. Lugs are to be provided by the electrical contractor to insure coordination with feeders and lug material types. Lugs are to be high compression crimp type only.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Bypass isolation

C. Draw-out type.

D. Delayed Neutral Position Operation: Provide switch operator with a programmed neutral position arranged to provide a midpoint between the 2 working switch positions with an intentional, controlled, timed pause during transfer at the midpoint. The midpoint pause is adjustable from 0.5 to 30 seconds minimum, and factory set at 1.0 second, except as indicated. Time delay occurs for both transfer directions.

E. 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.


G. Signal Before Transfer Contacts: Normally open/normally closed dry contacts operates in advance of retransfer to normal source, then reset after transfer is complete. Interval is adjustable from 1 to 30 seconds. Provide quantity of sets of contacts and control wiring, as required, to connect to all elevator or group controllers shown served by the ATS.

H. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

I. In-Phase Monitor: Not allowed.

J. Automatic Transfer-Switch Features:
TRANSFER SWITCHES

1. Undervoltage Sensing for Each Phase of Normal and Emergency 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 92 percent and dropout at 90 percent.

2. Adjustable Engine Start 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 two seconds.

3. Adjustable Transfer to Emergency Time Delay: For delaying transfer of standby ATS to generator source. Adjustable from zero to ten seconds, and factory set for five seconds.

4. 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.

5. 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. Proper phase rotation and angle shall be verified prior to transfer back to normal.

6. Key Operated Test Switch: 3 position ("Test With Load"/ "Automatic"/ "No-Load Test") maintained-contact switch with center Auto position. Switch shall simulate normal source failure, start generator and transfer or not transfer load based on operation of switch. Switch with OFF position is not acceptable.

7. Switch-Position LED type Pilot Lights: Indicate source to which load is connected. Incandescent lights are prohibited.

8. Provide pushbutton or control panel function to override time delay return to normal.

   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

10. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

11. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

12. 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.

13. 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 SOURCE QUALITY CONTROL

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.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.
   1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Identify components according to Division 26 Section "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 WIRING TO REMOTE COMPONENTS

A. Match the type and number of cables and conductors to the communications requirements of the transfer switches and generator remote annunciator panels used. Verify actual wiring requirements with ATS, elevator vendor and generator shop drawings prior to installation and increase raceway sizes at no additional cost to the owner if necessary to accommodate required wiring. Calculate voltage drop and increase wire size as required to accommodate voltage drop.

B. Provide separate conduits for Communication cables from DC and AC cables.

C. Provide separate conduits for DC cables from Communication and AC cables.

D. All conduit, wiring and electrical connections required between various items of the system shall be provided and installed complete.

3.3 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."

C. Tighten factory made connections, including connectors, terminals, bus joints, mountings, and grounding. Tighten field connected connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values. When manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

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 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.
TRANSFER SWITCHES

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. 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.

B. Coordinate tests with tests of generator and run them concurrently.

C. 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.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Demonstrate operation of transfer switch in the presence of the Facilities Electrical Supervisor & CPS Electrician and Commissioning Agent by operating normal power source under load and verifying transfer switch transfers to alternate source and back to normal source after normal power is restored.

C. Verify transfer switch status and source availability are annunciated properly to the power monitoring network.

END OF SECTION
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. Interior lighting fixtures, lamps, and ballasts
   2. Exit signs
   3. Lighting fixture supports

B. Related Sections:
   1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS
A. BF: Ballast factor.
B. CU: Coefficient of utilization.
C. CRI: Color-rendering index.
D. HID: High-intensity discharge.
E. LER: Luminaire efficacy rating.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS
A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Ballast, including BF.
   5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
      a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
      b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. 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.
INTERIOR LIGHTING

2. Wiring Diagrams: For power, signal, and control wiring.

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, using input from installers of the items involved:
   1. Lighting fixtures.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
   5. Structural members to which suspension systems for lighting fixtures will be attached.
   6. Other items in finished ceiling including the following:
      a. Air outlets and inlets.
      b. Speakers.
      c. Sprinklers.
      d. Smoke and fire detectors.
      e. Occupancy sensors.
      f. Access panels.
   7. Perimeter moldings.

D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
   1. Lamps: Specified units installed.
   2. Accessories: Cords and plugs.

E. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

F. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

G. Field quality-control reports.

H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers’ codes.

I. Warranty: Sample of special warranty.

1.5 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, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

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 NFPA 70.

E. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

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.

1.6 COORDINATION
A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Lighting placement must allow access to ballasts and lamps for the purpose of replacement and maintenance without damage to surrounding finishes, equipment, etc.

1.7 WARRANTY
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 Fluorescent Ballast and Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

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 Ballasts: Five years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: One year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 5% extra lamps are required at the end of projects for all specialty lamps installed.
   2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
   4. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS
2.1 MANUFACTURERS
A. In Interior Lighting Fixture Schedule where titles below are column or row headings that 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 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS
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.
INTERIOR LIGHTING

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. Diffusers 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. Acrylic lenses are not acceptable if lens must be removed to change lamps.
      a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass unless otherwise indicated.

I. 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.

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. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps - T5 and T5HO Lamps not acceptable.

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 Low-Temperature Environments:
   1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
   2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

E. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
   1. Dimming Range: 100 to 1 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and 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: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, 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 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 BALLASTS FOR HID LAMPS

A. Electronic Ballast for Ceramic Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Minimum Starting Temperature: Minus 20 deg F for single-lamp ballasts.
2. Rated Ambient Operating Temperature: 130 deg F.
3. Lamp end-of-life detection and shutdown circuit.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 20 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Lamp Current Crest Factor: 1.5 or less.
8. Power Factor: 0.90 or higher.
9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.6 QUARTZ LAMP LIGHTING CONTROLLER

A. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.

B. Standby (Quartz Restrike): Automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.

C. Connections: Designed for a single branch-circuit connection.

D. Switching Off: Automatically switches quartz lamp off when HID lamp strikes.

E. Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

2.7 EXIT SIGNS

A. General Requirements for Exit Signs: 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: LEDs, 70,000 hours minimum rated lamp life. Green lamps.
2. Hubbell/Presco Lite – Model PLED1EMGWW; or approved equal.

2.8 FLUORESCENT LAMPS
INTERIOR LIGHTING

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.

C. T5 - not acceptable

D. T5HO - not acceptable.

E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at three hours operation per start, unless otherwise indicated.
   1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
   2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
   3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
   4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
   5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
   6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
   7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.9 HID LAMPS

A. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4100 K unless otherwise indicated.

2.10 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:
   1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
   2. Install lamps in each luminaire.

B. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
INTERIOR LIGHTING

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures 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 lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.


3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Adjust aimable lighting fixtures to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. 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.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

PART 4 - LUMINAIRE CUTSHEETS

4.1 INDIVIDUAL LUMINARE SPECIFICATIONS

A. The following cutsheets and specifications shall be used as the basis of design. Manufacturers listed as alternates must meet the requirements of the specification.
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. Exterior luminaires with lamps and ballasts.
2. Luminaire-mounted photoelectric relays.
3. Poles and accessories.
4. Luminaire lowering devices.
B. Related Sections:
1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS
A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. HID: High-intensity discharge.
D. LER: Luminaire efficacy rating.
E. Luminaire: Complete lighting fixture, including ballast housing if provided.
F. Pole: Luminaire support structure, including tower used for large area illumination.
G. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION
A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.
C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.
D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
   1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph
      a. Wind Importance Factor: 1.0.
      c. Velocity Conversion Factors: 1.0.

1.5 SUBMITTALS
A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   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.
EXTERIOR LIGHTING

a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, CCT, CRI, lumens, 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.

B. Shop Drawings: 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. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
   4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

E. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

F. Field quality-control reports.

G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.6 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.

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.


E. Comply with NFPA 70.


1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.
EXTERIOR LIGHTING

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer’s standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

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

1. Lamps: One for every 100 of each type and rating installed. Furnish at least one of each type.
2. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated in the luminaire schedules on the drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

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.

1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: 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.
      a. Color: As selected by Architect from manufacturer's full range.

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.

O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp and ballast characteristics:
      a. "USES ONLY" and include specific lamp type.
      b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
      c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC 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. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
   1. Relay with locking-type receptacle shall comply with ANSI C136.10.
   2. Adjustable window slide for adjusting on-off set points.

C. Photocell over-ride is required with a manual and mechanical over-ride.

2.4 FLUORESCENT BALLASTS AND LAMPS

A. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Deg F and Higher: Electronic type rated for 0 deg F starting and operating temperature with indicated lamp types.
   2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.

B. Ballast Characteristics:
   1. Power Factor: 90 percent, minimum.
   2. Sound Rating: Class A.
   3. Total Harmonic Distortion Rating: Less than 10 percent.
   6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, 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.

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:
   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.

2.6 HID LAMPS

A. Low-Pressure Sodium Lamps: ANSI C78.43.

B. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000 K.

C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and CCT color temperature 4000 K.

E. High pressure sodium lamps are not allowed.
2.7 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

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 “Structural Analysis Criteria for Pole Selection” Article.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

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.


3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all.

E. 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.”

F. 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.

G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.8 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Round, tapered.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single or double arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.

3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaires or luminaires and brackets indicated, and securely fastened to pole top.

E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
EXTERIOR LIGHTING

G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Factory-Painted Finish: 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 with SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. 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.
      a. Color: As selected by Architect from manufacturer's full range.

2.9 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429/B 429M, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
   1. Shape: Round, tapered.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as pole

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

G. Aluminum Finish: 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...
EXTERIOR LIGHTING

colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: As selected by Architect from manufacturer's full range.

2.10 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.
   1. Recessed, 12 inches above finished grade.
   2. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, that when mounted results in NEMA 250, Type 3R enclosure.
   3. With cord opening.
   4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s) or indicated accessories.

2.11 PARKING LOT LIGHTING

A. Light source to be metal halide lamps, 250-400.

B. Pole height shall be no more than 25ft.

2.12 SITE SECURITY LIGHTING

A. Light source shall be metal halide.

B. Lighting control by photocell.

2.13 OWNER FURNISHED CONTRACTOR INSTALLED (OFCI) LIGHT POSTS, LAMPS AND LUMINAIRES:

A. Post: Visco, painted campus standard green.

B. Fixture: Holophane IGV10DHMT6806. (Agate St. only: Sternberg 4410-DPF fixtures.)

C. Globe: Granville G-V-8N. (Agate St. only, D650 globes)

D. Junction boxes shall be installed adjacent to exterior post lights.

E. One tenon adapter per fixture/pole with ¼" 20 thread set screw to fasten the adapter to the tenon.

F. 10-ft poles, 100 watt metal halide.

G. 12-ft poles, 150 watt metal halide.

H. 120 volt or 208 volt power only.

I. Light pole bases are to be anchored.

J. Light pole base may have an optional 120 volt receptacle with welded adapter. This receptacle access is to be either (1) a keyed cover, or (2) labeled with panel and circuit location to be turned on and off by appropriate personnel as needed.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
EXTERIOR LIGHTING

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Dig holes large enough to permit use of tampers in the full depth of hole.
2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

H. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRES INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES
EXTERIOR LIGHTING

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Aim fixtures at completion of project, as appropriate to address glare control and light trespass issues.

C. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

D. Illumination Tests:
   1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
      b. IESNA LM-64, "Photometric Measurements of Parking Areas."
      c. IESNA LM-72, "Directional Positioning of Photometric Data."

E. 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.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes pathway requirements specifically applicable to the communications sections of this project.

B. Furnish and install communications conduit raceways, boxes, cable trays, innerduct and fittings including:
   1. Communications conduit systems.
   2. Wireway systems.
   3. Surface raceway systems.
   4. Telecommunications outlet boxes.
   5. Pull box enclosures.
   6. Cabinets.
   7. Pulltape and duct plugs.
   8. Raceway identification banding.

1.2 RELEVANT SECTIONS

A. 27 13 13 Telephone Backbone Cabling
B. 27 13 23 Optical Fiber Backbone Cabling
C. 27 15 13 Category 5e Horizontal Cabling
D. 27 70 80 Cable Television Cabling

1.3 SUBMITTALS

A. Provide the manufacturer’s cut sheets, clearly indicating specific products proposed for use, with the bid submission.

1.4 PROJECT RECORD DOCUMENTS

A. Plan drawings showing completions and as-built corrections which indicate type, size, placement, routing, and/or length for raceway and cable tray components; e.g., manholes, hand holes, conduit, wireway, boxes, enclosures, etc.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Equivalent product(s) may be considered for substitution for those products specified, however, the equivalent product(s) to be approved and show demonstrated and documented equivalence to the product(s) specified. Documentation to include, but is not limited to: product samples, data sheets, and actual test data. The request for product substitution, and supporting documentation, to be submitted, in writing, prior to submitting the bid. Written approval for product substitution to be submitted with the bid.

2.2 GENERAL

A. Raceways, Boxes, Enclosures, Cable Tray Materials and Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended.
The product identification codes used for the Communications Raceways and Boxes in Part 2, Products, are summarized in Table 1.

<table>
<thead>
<tr>
<th>Product Designation</th>
<th>Product Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGS</td>
<td>Rigid galvanized steel</td>
</tr>
<tr>
<td>CRS</td>
<td>PVC externally coated RGS</td>
</tr>
<tr>
<td>EMT</td>
<td>Galvanized steel tubing</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinylchloride conduit</td>
</tr>
<tr>
<td>ENT</td>
<td>Electrical nonmetallic tubing</td>
</tr>
<tr>
<td>LMC</td>
<td>Liquidtight metal conduit</td>
</tr>
<tr>
<td>LNC</td>
<td>Liquidtight nonmetal conduit</td>
</tr>
</tbody>
</table>

2.3 RIGID METAL CONDUIT AND FITTINGS

A. Conduit:
1. Type RGS: Rigid galvanized steel.
2. Type CRS: PVC externally coated conduit; rigid steel conduit with external PVC coating and internal galvanized surface.

B. Fittings and Conduit Bodies: In-line straight-through, threaded, galvanized steel fittings and Type C conduit bodies only; do not use bends or tees, e.g., Lbs.

C. Bonding and Grounding Locknuts and Wedges: Malleable iron with set screws and lug screws.

D. Insulated Bushing: Malleable iron with integral insulated throat, rated for 150 degrees C.

E. Bonding and Grounding Bushing: Malleable iron with integral insulated throat, rated for 150 degrees C, with solder-less lugs or lug screws.

F. Sealing Fittings: Threaded type conduit seal fittings and sealing compound suitable for hazardous location installations in accordance with NEC:
1. Crouse-Hinds retrofit sealing fitting EYSR.
2. Crouse-Hind CHICO A sealing compound.

2.4 ELECTRICAL METALLIC TUBING AND FITTINGS

A. Type EMT: Electrogalvanized steel tubing.

B. Fittings and Conduit Bodies:
1. General: in-line straight-through steel or malleable iron fittings and Type C conduit bodies only; do not use bends or tees, e.g., LBs.
2. Wet Areas: steel compression-type couplings and nipples.
3. Dry Areas: set screw-type couplings and nipples.

C. Bonding Locknuts: Malleable iron with set screws and lug screws.

D. Insulated Bushing: Malleable iron with integral insulated throat, rated for 150 degrees C.

E. Bonding and Grounding Bushing: Malleable iron with integral insulated throat, rated for 150 degrees C, with solderless lugs or lug screws.

2.5 CONDUIT ACCESSORIES

A. Duct Spacers: Nonmetallic base and intermediate duct spacers with locking keyways designed specifically for use with nonmetallic conduit; e.g., Carlon SNAP-LOC duct spacers for 4-inch (100 mm) diameter conduit with 1-1/2-inch (38 mm) separation.
1. Base Spacer: S288NHN.
2. Intermediate Spacer: S289NHN.
COMMUNICATIONS PATHWAYS

B. Expansion/Deflection Fittings: Similar to Crouse-Hinds XD expansion/deflection coupling or Appleton DF Series deflection and expansion coupling.

C. Pulltape: Measuring and pulling tape constructed of synthetic fiber with plastic jacket, printed with accurate sequential footage marks; e.g., George-Ingraham 1/2-inch (13 mm) tape 9216-JK.

D. Duct Plugs:
   1. Aboveground Conduit Openings: Tapered PVC plugs with tab for pulltape; e.g., Carlon 4-inch (100 mm) PVC plugs with pull tab, P258NT.
   2. Underground or Underslab Conduit Openings: Removable screwtight compression type duct plugs with wing-nut and corrosion resistant hardware; e.g., Pacific Plastics No. 5900514, George-Ingraham 0605, or Vikimatic P4000WT.

2.6 RACEWAY COATING

A. Acceptable Manufacturers:
   1. Koppers Bitumastic.
   2. Scotchwrap.

2.7 PENETRATION SEALING SYSTEMS

A. Firestopping: Provide fire barrier penetration sealing materials as specified in Firestopping section.

B. Duct Water Seal: Products suitable for closing underground and entrance duct openings, where innerduct or cable is installed, to prevent entry of gases, liquids, or rodents into the structure; e.g., SEMCO PR 851.

2.8 TELECOMMUNICATIONS OUTLET BOXES

A. Sheet Metal Outlet Boxes: Minimum 4-inch by 4-inch by 2-inch-deep (100 by 100 by 50 mm-deep) galvanized steel for use with single- and double-gang plaster rings.

B. Nonmetallic Outlet Boxes: Minimum 4-inch by 4-inch by 2-inch-deep (100 by 100 by 50 mm-deep). Provide gasketed, watertight cover.

C. Cast Boxes: 4-inch by 4-inch by 2-inch-deep (100 by 100 by 50 mm-deep) cast Feralloy, gasketed single- or double-gang cover, threaded hubs. For hazardous locations, provide boxes approved for applicable atmosphere classification.

D. Floor Boxes for Installation in Cast-In-Place Concrete Floors: Flush mounted and fully adjustable formed steel as shown on the Drawings.

E. Plaster Rings: Single or double gang as shown on the Drawings.

2.9 PULL BOXES

A. Construction: NEMA Standard No. 250.
   1. Type 1 Steel: Galvanized steel enclosures designed for use as junction boxes and pull boxes with flat screw-applied covers, with or without knockouts, and gray enamel finish.

2.10 OUTSIDE PLANT VAULTS/HANDBOLES

A. Preformed concrete with metal cover or cast iron manhole cover. Utility Vault company or equivalent.

2.11 INNERDUCT

A. Outdoor Innerduct: 1-inch (25 mm) and 1-1/4-inch (32 mm) inside diameter corrugated, ribbed, or smooth walled, semi rigid PVC or heavy-wall polyethylene tubing.
COMMUNICATIONS PATHWAYS

B. Indoor Innerduct: 1-inch (25 mm) and 1-1/4-inch (32 mm) inside diameter corrugated, ribbed, or smooth walled, semi rigid nonflammable PVC tubing, which meets UL94V-O vertical flame test for general applications.

C. Plenum-Listed Indoor Innerduct: 1-inch (25 mm) and 1-1/4-inch (32 mm) inside diameter corrugated walled innerduct for use in plenum air handling spaces.

2.12 INNERDUCT FITTINGS

A. Couplings: Metallic or nonmetallic quick-connect, reverse threaded, and Schedule 40 couplings for connecting sections of installed innerduct.

B. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing the outside walls of one or more innerduct ends to the inside wall of 4-inch (100 mm) inside diameter conduits, e.g.:
   1. Four 1-inch (25 mm) innerduct configuration.
   2. Three 1-1/4-inch (32 mm) innerduct configuration.

C. Innerduct Plugs: 1-inch (25 mm) and 1-1/4-inch (32 mm) compression-type innerduct plugs for sealing innerducts, with wing nut for hand tightening and eyebolt for securing pulltape.

D. Innerduct Caps: Removable push-in caps for plugging 1-inch (25 mm) and 1-1/4-inch (32 mm) innerduct.

2.13 WIRE BASKET RUNWAY SYSTEMS

A. Manufacturers: Subject to compliance with these Specifications, install wire basket runway. Cablofil, FlexTray, GS Metals.

B. Cable Tray Sections and Components:
   1. General: Except as otherwise indicated, provide metal wire basket runways, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

C. Type of Runway System:
   1. Tray sizes have 2 or 4-inch side height.
   2. Supply all straight sections in standard 120 inches, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on Drawings.
   3. Tray Widths: 6 inches, 12 inches, 18 inches, 24 inches.
   4. Make splice plates the fast splice type as indicated below for each tray type.
      a. Make splice plates of yellow zinc dichromate steel.
      b. Furnish splice plates with straight sections and fittings as required by manufacturer.
      c. Finish: Electro zinc.
   5. Wire Basket Runway Supports: Place so that the support spans do not exceed a maximum of 4 feet o.c.

D. Loading Capacities: Wire basket runways to meet NEMA Class Designations.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Manufactured products, materials, equipment, and components to be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer’s specifications and printed instructions.

B. The installation of all system components to be carried out under the direction of qualified personnel. Appearance to be considered as important as mechanical and electrical efficiency. Workmanship to meet or exceed industry standards.
COMMUNICATIONS PATHWAYS

C. Place support for framing, raceways, cable trays, backboards, equipment racks, and cabinets.

3.2 PROTECTION DURING CONSTRUCTION

A. Protect products from the effects of moisture, corrosion, and physical damage during construction. Except during installation activity in a section, keep openings in conduit, tubing, and wireway capped with manufactured seals during construction.

3.3 MINIMUM CONDUIT SIZE

A. 1-inch (25 mm) for aboveground installations unless otherwise indicated on the Drawings.
B. 4-inch (100 mm) for underground applications unless otherwise indicated on the Drawings.

3.4 CONDUIT TYPE TO BE USED

A. Install the following types of circular communications raceway in the locations listed unless otherwise indicated on the Drawings.
   1. Interior Dry Locations, Exposed: EMT with set screw fittings.
   2. Interior Dry Locations, Concealed (Not Embedded in Concrete): EMT with set screw fittings.
   3. Interior Wet Locations: EMT with compression fittings.
   5. Concrete-Encased or Buried Duct Banks:
      a. PVC Schedule 40 conduit.
      b. Rigid steel conduit when additional protection is required.
   6. Flexible Conduit (Interior Exposed):
      a. Liquidtight flexible metal conduit for use with copper cable.
      b. Liquidtight flexible nonmetallic conduit for use with fiber optic cable.
   7. Conduits that are to be used for service entrance conductors shall be either:
      a. Concrete encased PVC schedule 40 or
      b. Rigid or Intermediate metallic conduit (RMC or IMC)

3.5 CONDUIT BENDS AND SWEEPS

A. Make changes in direction of communications conduit runs with sweeps of the longest possible radius.
B. Make sweeps in parallel or banked runs of conduits, 2 inches (50 mm) and larger in diameter, from the same center or centerline so that sweeps are parallel and of neat appearance.
C. Field-Made Bends and Sweeps:
   1. Use an acceptable hickey or conduit-bending machine.
   2. Do not heat metal raceways to facilitate bending.
   3. Before installing 4-inch (100 mm) field-made sweeps in duct banks, pull a 3-1/2-inch (89 mm) diameter by 12-inch (300 mm) long mandrel through duct sections to verify circularity and sweep radius.
D. The angular sum of the bends between pull points and/or pull boxes to not exceed 180 degrees.
E. Minimum Inside Bend Radius for Communications Conduit Bends, Sweeps, Boxes, and Fittings:
   1. Underground or Underslab 4-inch (100 mm) Conduit: 60 inches. (1.5 m)
   2. Other Conduit Runs:
      a. One-inch (25 mm) conduit, 11 inches (275 mm).
      b. Two-inch (50 mm) conduit, 21 inches (525 mm).
      c. Three-inch (75 mm) conduit, 31 inches (775 mm).
      d. Four-inch (100 mm) conduit, 40 inches (1000 mm).
      e. Other sizes, 10 times the inside diameter of the conduit.
F. Do not install boxes, bends, elbows, tees, conduit bodies, and other conduit fittings, which do not provide for the minimum inside cable bend radius specified in paragraph E above.
COMMUNICATIONS PATHWAYS

1. Conduit Bodies: in-line straight-through Type C condulet fittings are not allowed for pull points. Other conduit fittings, which include direction changes such as E, L, LB, LR, LL, LRT, TA, TB, and X, are not allowed. Utilize appropriate sized metallic junction box.

2. Refer any design or installation conflicts with these requirements to the Owner.

3.6 PENETRATIONS

A. Seal conduit entering structures at the first box or outlet to prevent the entrance of gases, liquids, or rodents into the structure.
   1. Empty Conduits: Removable screwtight duct plugs.
   2. Innerduct Installed: Suitable duct water seal between conduit and innerduct. Manufactured seals in empty innerduct.
   3. Cable Installed: Suitable duct water seal between conduit and cable, or between innerduct and cable. Grout or duct seal not to exceed 3-inch depth inside raceway.

B. Concrete Sleeves: Conduits routed perpendicular through floors, walls, or other concrete structures to pass through cast-in-place conduit sleeve openings wherever possible, or appropriate size holes to be bored to accommodate the installation of conduit sleeves. The size and location of the holes to not impair the structure’s integrity.
   1. Concrete Boring: Bore a hole in the concrete with a diameter of 1/2 to 1 inch (13 to 25 mm) larger than the conduit sleeve to be installed. Grout around the conduit sleeve and finish to match existing surroundings.
   2. Conduits that rise vertically through a slab to be stubbed 6-inches (150 mm) above the floor and capped pending future use.

C. Drywall Sleeves: Install insulating throat bushings on both ends of conduit sleeves placed in fire-rated walls using drywall construction.

D. Where conduit enters a structure through a concrete roof or membrane waterproofed wall or floor:
   1. Provide a watertight seal.
   2. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
   3. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
   4. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

E. Where raceways penetrate fire-rated walls, floors, or ceilings, fire stop openings around communications penetrations to maintain the fire-resistance rating as specified in Firestopping section.

3.7 ABOVE-GROUND CONDUIT INSTALLATION

A. Support conduit installed in aboveground interior and exterior locations at a maximum of 7 feet (2.1 m) on center.

B. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps.

C. Securely attach aboveground conduit under the provisions of this Section.

D. Conceal conduit in finished areas, leave exposed in unfinished areas and where not possible to conceal. In finished areas, the Owner will make the final decision on conduit concealment.

E. Run exposed and concealed conduits parallel or perpendicular to walls, structural members, or intersections of vertical planes to maintain headroom and provide a neat appearance. Follow surface contours as much as possible.

F. No section of conduit located within buildings to exceed 100 feet (30 m) in length between pull points and/or pull boxes. Pull points in conduits shall be boxes or wireway.
COMMUNICATIONS PATHWAYS

G. Expansion/Deflection Joints:
   1. Where indicated on the Drawings, provide specific purpose expansion/deflection fittings for conduit crossing building expansion/deflection joints in structures or concrete slabs. Expansion fittings to have copper bonding jumper.
   2. For PVC conduit, provide expansion/deflection joints for 25 degrees F maximum temperature variation. Install in accordance with manufacturer’s instructions.
   3. For rigid steel conduit located in exterior areas, provide expansion/deflection joints for maximum site temperature variation, installed in accordance with manufacturer’s instructions.

H. Provide each conduit passing from a nonhazardous or noncorrosive area to a hazardous area and each conduit entering an enclosure within a hazardous area with a sealing fitting in accordance with NEC Article 500. The sealing fitting to be UL listed and to be filled with approved sealing compound of the same manufacture.

I. Hubs, Bushings, and Insulating Sleeves:
   1. Interior Box and Cabinet Connections: Install insulating throat connectors wherever conduit terminates in boxes or cabinets. In addition, install bonding type locknuts at metallic conduit terminations.
   2. Wet and Hazardous Box and Cabinet Connections: Use watertight threaded conduit sealing hubs with insulated throat and bonding type locknuts for fastening rigid steel conduit to cast or sheet metal pull boxes.
   3. Exposed Conduit Terminations: Cap exposed steel communication conduit ends with bushings or smooth collars to protect cable sheath.

J. Flexible Conduit:
   1. Make no bends in flexible conduit that exceed allowable bending radius of the cable to be installed or that significantly restricts the conduit’s flexibility.
   2. A flexible conduit section to be long enough to allow the item to which it is connected to be withdrawn or moved off its base.
   3. For final connection to TO’s or equipment, where flexible connection is required to minimize vibration or where required to facilitate removal or adjustment of equipment, provide 12-foot (3600 mm) minimum lengths of flexible conduit or as indicated on the Drawings.
   4. Minimum size for flexible conduit shall be 1.25-inches.

3.8 PULLTAPE AND DUCT PLUGS

A. Following conduit installation, install pulltape (muletape) with preprinted foot markers in each empty conduit containing a bend or over 10 feet (3000 mm) in length, except sleeves, nipples, and runs with openings in cleanroom areas. Tie the pulltapes securely to duct plug or wall racking at each end.

B. Immediately after pulltape installation, for conduit openings on conduits underground, install screwtight, removable, watertight, and dust-tight duct plugs in conduit ends.

C. Verify lengths at the time of installation and provide as-built documentation.

3.9 WIREWAY TYPE TO BE USED

A. Install the following types of wireway in the locations listed unless otherwise indicated on the Drawings:
   1. Interior, Exposed: steel.
   2. Interior, Concealed: not approved.
   3. Exterior, Exposed: steel or nonmetallic.

3.10 WIREWAY INSTALLATION

A. Install wireway, as indicated on the Drawings.
COMMUNICATIONS PATHWAYS

B. Securely support wireways at intervals not to exceed 5 feet (1500 mm) and at each end or joint for individual sections.

C. Attach wireways and related materials under the provisions of this Section.

D. Run exposed wireways parallel or perpendicular to walls, structural members, or intersections of vertical planes to maintain headroom and provide a neat appearance.

E. Close dead ends of wireway with fittings by the same manufacturer.

F. Gasket each joint in oiltight gutter.

G. Mount raintight gutter in horizontal position only.

H. Maintain grounding continuity between raceway components to provide a continuous grounding path.

3.11 TELECOMMUNICATIONS OUTLET BOX INSTALLATION

A. Provide 4-inch by 4-inch by 2-inch (100 mm by 100 mm by 50 mm) deep outlet boxes for mounting telecommunications outlets with single- or double-gang plaster rings as required, or as indicated on the Drawings.

B. Do not install outlet boxes back to back in walls. Provide minimum 6-inch (150 mm) separation, except provide minimum 24-inch (600 mm) separation in acoustic-rated walls.

C. Locate outlet boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for outlet boxes. Use boxes with sufficient depth to permit conduit hubs to be located in masonry void spaces.

D. Provide knockout closures for unused openings.

E. Support telecommunications outlet boxes independently of conduit.

F. Use multiple-gang boxes where more than one device is mounted together; do not use sectional outlet boxes.

G. Install outlet boxes in walls without damaging wall insulation.

H. Coordinate mounting heights and locations of outlet boxes mounted above counters, benches, and backsplashes.

I. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlet boxes in hollow stud wall.

J. Provide cast outlet boxes in exterior and wet locations.

3.12 RACEWAY IDENTIFICATION BANDING

A. Degrease and clean surfaces to receive tape labels.

B. Exposed conduits and wireway, including raceways above lay-in or accessible ceilings, together with associated pull boxes to be banded at intervals of not over 10 feet (2500 mm) and at direction changes. Two-band identification to be different contrasting colors as follows:

<table>
<thead>
<tr>
<th>Raceway Use</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grounding</td>
<td>Green</td>
</tr>
<tr>
<td>Building fire alarm system/voice evacuation</td>
<td>Red</td>
</tr>
<tr>
<td>Telecom/data</td>
<td>Yellow</td>
</tr>
<tr>
<td>Facility management system (FMS) and general control circuitry</td>
<td>Blue and black</td>
</tr>
<tr>
<td>CCTV</td>
<td>White</td>
</tr>
<tr>
<td>Building monitoring and security</td>
<td>Gray</td>
</tr>
<tr>
<td>Controls (non-FMS)</td>
<td>Brown and white</td>
</tr>
</tbody>
</table>
3.13 GENERAL CABLE TRAY INSTALLATION METHODS
A. Cut standard straight sections of materials to length in the field.
B. Deburr and file rough cable tray edges and any cut sections.
C. Cable tray locations shown on the Drawings are approximate unless dimensioned.
D. Install cable tray as shown on the Drawings and securely attach under the provisions of this Section.
E. All cable tray ladder or trough to be accessible.
F. Maintain minimum 6-inch (150 mm) clearance between cable tray and piping. Locate cable tray at least 12 inches (300 mm) away from heat sources such as parallel runs of flues, steam or hot water pipes, and heating appliances.
G. Run exposed and concealed cable tray parallel or perpendicular to walls, structural members, or intersections of vertical planes to maintain headroom and provide a neat appearance.
H. Passageways to not be obstructed.
I. Cable tray routed at the ceiling to be routed within the assigned communications utility space.
J. Install appropriate cable tray bends, dropouts, and other accessories to protect minimum cable bend radius and provide adequate support at locations where cable direction changes occur.

3.14 PENETRATIONS
A. Provide firestopping per code requirements at all fire wall penetrations.

3.15 INNERDUCT TYPE TO BE USED
A. Underslab and Underground Conduit Installation: Outdoor or indoor innerduct.
B. Aboveground, Exterior, and Interior Conduit Installations: Indoor innerduct.
C. Interior Exposed Locations Including Cable Tray Installations:

3.16 INNERDUCT INSTALLATION
A. Pull innerduct through conduit and wireways, or place innerduct in cable trays using continuous unspliced lengths of innerduct between pull boxes, and/or section termination points as indicated on the Drawings.
B. Cut innerduct square. Deburr cut ends.
C. Bring innerduct to the shoulder of fittings and couplings and fasten securely.
D. Wipe innerduct and fittings clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.
E. Provide suitable innerduct slack in pull boxes, and at turns to ensure that there is no kinking or binding of the tubing.
F. Make changes in direction of communications innerduct runs with sweeps of the longest possible radius and at least 10 times the inside diameter of the innerduct.
G. During innerduct pulling, care to be taken to avoid excessive tension, which can cause deformation of the innerduct. Inspect innerduct following placement and replace any damaged sections.
H. Indoor Conduit Installation:
COMMUNICATIONS PATHWAYS

1. Arrange innerduct neatly, cut to proper length, and remove surplus. Provide trained and bundled innerduct pigtails extending at least 18 inches (450 mm) beyond exposed conduit openings.

2. At locations where the ends of innerduct sections appear in a pull box, join the pulltape and trim/deburr the ends on the innerduct.

I. Cable Tray Installation: Tie wrap innerduct to one side of vertical ladder rack every 2 feet (600 mm) minimum, and to one side of horizontal ladder-type cable tray every 5 feet (1500 mm) minimum.

J. Following installation, visually inspect innerduct, remove any burrs at openings, and, if necessary, clean innerduct interior.

3.17 PULLTAPE AND INSTALLATION

A. All conduit runs longer than 10ft shall have pulltape with pre-printed footage markers installed.

B. Following conduit or innerduct installation, install pulltape (muletape) with preprinted foot markers in all sections longer than 10ft, except runs with openings serving cleanroom areas. Tie the pulltape securely to wall racking at each location.

C. Verify lengths at the time of installation and provide as-built documentation.

3.18 GROUNDING

A. Provide ground connections and bonding continuity between raceway and cable tray sections, boxes, enclosures, cabinets, and fittings as required.

END OF SECTION
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. Telecommunications mounting elements.
   2. Backboards.
   3. Telecommunications equipment racks and cabinets.

B. Related Requirements:
   1. Division 27 Section "UO Telecom Standards".
   2. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
   3. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS


B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
   3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Material Safety Data Sheets.

C. Seismic Qualification Certificates: For equipment frames 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. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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

1.6 QUALITY ASSURANCE

A. Do all work in accordance with the guidelines published in EIA/TIA standard 568 and 569. Where conflicts exist, the plans and specification shall take precedence. All manufacturer installation instructions shall be followed.

B. Horizontal cabling system shall be provided with a one year system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of at least 1 year and will include all labor and materials to correct any defect during the warranty period.

C. The contractor shall have completed Panduit product and installation training.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 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."

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

1. Fire retardant shall be Class A rated
2. Plywood shall contain no added Urea formaldehyde.
3. Plywood shall be FSC certified.

2.3 EQUIPMENT FRAMES

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

1. Chatsworth.
2. Panduit Corp.

B. General Frame Requirements:

1. Distribution Frames: Freestanding modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, steel construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.
3. Chatsworth #55053-503 7 foot freestanding relay rack

D. Horizontal Cable Management for Equipment Frames:

1. Lightweight plastic construction provides durability and easy installation.
2. Removable front cover hinges 180° up or down to allow access without removing cover
3. Curved surfaces maintain cable bend radius.
4. Pass-through holes allow for front to rear cabling.
5. Built in cable retainers hold cable in place for easy moves, adds, and changes.
6. Mount to 19” EIA racks and cabinets.
7. Panduit WMPF2E

E. Large Horizontal Cable Management for Equipment Frames:
1. 6” x 2.8” Heavy Duty Aluminum Rings
2. Removable Rounded edge cable rings
3. Chatsworth 40093-703.

2.4 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.5 LADDER CABLE TRAYS

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

B. Description:
   1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
   2. Rung Spacing: 6 inches (150 mm)
   3. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
   4. No portion of the rungs shall protrude below the bottom plane of side rails.
   5. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
   6. Straight Section Lengths: 10 feet (3 m) except where shorter lengths are required to facilitate tray assembly.
   7. Width: 18 inches (300 mm) unless otherwise indicated on Drawings.
   8. Splicing Assemblies: Bolted type using serrated flange locknuts.
   9. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Ladder Cable Tray Accessories:
   1. Cable Runway Radius Drop: Chatsworth 12100-7XX.
   2. 6-inch Cable Retaining Posts: Chatsworth 10596-706.
   3. Mounting hardware, splices, grounding kits, and support brackets: Chatsworth.

2.6 POWER DISTRIBUTION FOR RACKS

A. Rack power distribution to be provided and installed by University of Oregon NTS.

2.7 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:
1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.

3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Division 27 Section "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 27 Section "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

- with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

  D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
  1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.6 IDENTIFICATION

  A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

  B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

  C. Labels shall be preprinted or computer-printed type.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED
A. Furnish and install all labor and materials required for the installation of a voice backbone cabling distribution system. This system is intended to provide for distribution of traditional analog and digital dial tone. Owner will provide all patch cords, cross connects, networking equipment, telephone and monitoring equipment. Close coordination with the owner will be required.

1.2 RELEVANT SECTIONS
A. 27 05 28 Telecommunications Pathways
B. 27 13 23 Optical Fiber Backbone Cabling
C. 27 15 13 Category 5e Horizontal Cabling
D. 27 70 80 Cable Television Cabling

1.3 QUALITY ASSURANCE
A. Do all work in accordance with the guidelines published in EIA/TIA standard 568 and 569. Where conflicts exist, the plans and specifications shall take precedence. All manufacturer installation instructions shall be followed.
B. All workers involved in the installation and termination of cable shall have at least one year of experience. No less than 33% of the workmen on the job shall have attended a vendor sponsored training program covering installation and termination of cable.

1.4 SUBMITTALS
A. Submit five sets of shop drawings and product data (or a greater number if specified in Division 1 “Submittals” Section). Submittals will be required for the following items.
   1. Product data for all products being proposed.

1.5 GUARANTEE
A. Guarantee all work against faulty and improper material and workmanship for a minimum period of 1 year from the date of final written acceptance by Owner, except where guarantee or warranties for longer terms are specified herein.
B. Upon notification of a problem, the warranty provider shall furnish within 48 hours and at no cost to the owner, such labor and materials as are needed to restore the system to proper operation.

PART 2 - PRODUCTS

2.1 PRODUCTS
A. Outdoor telephone backbone
   1. Backbone cable: any 24 AWG REA PE89 or PE39 cable, pair count as specified on drawings.
   2. Termination: Circa Enterprises 1880 ECA, sized to match pair count of cable, fully populated with Circa 3B1FS 5-pin protector modules.
B. Indoor telephone backbone
   1. Backbone cable: Any ARMM type shielded twisted pair, pair count as specified on drawings.
   2. Termination: 110 blocks with legs with C5 block connectors, sized appropriately to accommodate specified pair count.
3. **110 wire management:** Jumper troughs installed between each 300 pair of 110 blocks.

### PART 3 - EXECUTION

#### 3.1 GENERAL INSTALLATION

A. The Contractor shall furnish and install all cabling in accordance with these specifications, and as indicated on the cable schedules and drawings. Manufacturer installation specifications shall take precedence if there is a conflict with this section.

B. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical coupler installed between the cable points of origin and termination except as shown on drawings and or specifications.

C. Contractor is responsible for insuring that cable jacket is suitable for the environment in which it is placed i.e.: CM, CMR, CMP rated. Unless otherwise noted on the drawings, all cable should be assumed to be rated CMR.

D. All cable shown on drawings to be routed in conduit and cable tray system, where provided.

E. At the same time cable is pulled into a cable pathway, also install a mule tape of appropriate size to facilitate future cable pulls along those pathways.

F. Surface mounted raceway or exposed cable not specifically designated require written approval of the architect.

G. Provide fire stopping at all locations where cables penetrate fire rated surfaces. Materials and methods used shall be acceptable to the code authority having jurisdiction and shall maintain the fire integrity of the wall, floor, or ceiling.

H. Contractor shall closely coordinate and work with the owner on the construction of racking and panels and termination and routing of the cabling in the telecommunications room, overhead basket tray, and into the open relay racks.

#### 3.2 TELEPHONE BACKBONE INSTALLATION

A. Follow manufacturer instructions when installing and terminating cable.

B. When breaking out cables with more than one 25-pair binder group, each binder group must be identified with a cable tie of appropriate color at the point of fan out.

C. Outdoor telephone backbone cable:
   1. Terminate cable in lighting protection units on both ends of the cable.
   2. Install shield bond connectors at each end of each cable. Bond this connector to the bonding point inside the lightning protection unit.
   3. Bond the lightning protection unit to the telecommunications grounding busbar.

D. Indoor telephone backbone cable:
   1. Terminate cable onto wall mounted 110-blocks. The location of this telephone backbone cabling block shall be coordinated with the work specified in the horizontal cabling section. The telephone backbone cabling block shall be placed under any 110-blocks installed as part of the work specified by the horizontal cabling specification.
   2. The backbone cable terminated on 110-block will be overlaid with 25 pair cable and extended to the relay rack to terminate on a 24 port RJ-11 patch panel. The overlay cable shall be a pigtail with a 50 pin Amphenol connector to mate with the patch panel. Coordinate panel location with owner.
   3. Install shield bond connectors at each end of each cable. Bond this connector to the telecommunications grounding busbar.

E. Lightning protection, backbone 110-blocks, and special dial tone 110-blocks shall be organized into a logical and easy to use cross connect field, with suitable wire management for cross
TELEPHONE BACKBONE CABLING
connects between blocks, both vertically and horizontally. The scope of this work does not include installation of the special dial tone 110-blocks, however, it does include coordination with this work to provide a logical and easy to use cross connect field complete with cable management for routing of cross connect jumpers.

3.3 IDENTIFICATION

A. Telephone Backbone Cable Identification
   1. Each telephone backbone cable shall be assigned a unique identifier consisting of the following components:
      a. Abbreviation for the originating telecommunications room. Typical originating telecommunications room is MDF.
      b. Abbreviation for the terminating telecommunications room. Typical terminating telecommunications room will be IDF-B, IDF-C, etc.
      c. Pair count.

2. The unique cable ID shall be constructed from these 3 components. For example, if you were labeling a 25 pair cable that is run from the MDF room to IDF D, your cable label would be MDF-IDF-D-25.

3. Cable shall be labeled at each telecommunication room, near the location that the cable enters the telephone punch blocks.

4. Cable shall be labeled every 50’ along the length of the cable in open trays, and on each side of all wall penetrations.

5. Cable routed in conduit systems shall be labeled at each pull point. This includes the every time cable enters or exits a conduit, j-box, or pull vault.

6. Labels shall consist of permanent typewritten label systems. Hand written labels are not acceptable.

3.4 IDF AND SERVICE ENTRANCE ROOMS

A. Construction of the backboards, overhead ladder racking, and open relay racks is specified in other sections and is not included in work specified in this section.

B. Telephone backbone cable shall be routed onto overhead ladder racking systems and around the room to the backboard location indicated for termination of telephone backbone cabling.

3.5 TERMINATION HARDWARE

A. Quantities of termination blocks, racks, splice enclosures, and patch panels, etc. shown on drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of termination hardware required to terminate the volume of cable described herein and shown on the drawings.

3.6 CROSS-CONNECT

A. The owner will perform all cross-connects and patching unless otherwise noted.

3.7 GROUNDING

A. This specification does not include a grounding system. Grounding is specified elsewhere. That work will install a ground busbar mounted on the backboard in the IDF.

B. A 6AWG insulated conductor shall be run from the telecommunications grounding busbar to the shield of the indoor cable or to the ground point of the outdoor lightning protection.

C. All grounding shall be in compliance with the NEC code Article 800, Article 250, well as EIA/TIA standard 607.

3.8 CABLE TESTING

A. General
   1. Provide 48 hour advance notice of testing.
2. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.

3. Conduct cable testing as described below upon completion of installation. Test fully completed systems only.

4. Remove all defective cables from pathways system. Do not abandon cables in place.

5. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.

6. The Engineer further reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent (5%) of the cable plant to confirm documented test results.

7. All test results and corrective procedures are to be documented and submitted with the as-built drawings.

B. Telephone backbone testing

1. All telephone backbone twisted pair cabling shall be tested for grounds, shorts, continuity of conductors and shields, reversals, and transpositions. The contractor shall guarantee 99% good pairs on all backbone cable with no more than one bad pair in any binder group.

3.9 ACCEPTANCE

A. Upon receipt of the Contractor's documentation of cable testing, the Engineer will review the installation and may request a test in his presence, of up to 1% of the cables/wires installed.

3.10 AS-BUILT DOCUMENTATION

A. As built documentation shall include 3 copies of the following:

1. Annotated CAD prints and disks of the electrical set of prints indicating routes of installed cables, slack loop locations, and termination points.

2. All test results both in machine readable format as well as printed neatly bound and organized. Each test shall clearly indicate cable and pair designations.
PART 1 - GENERAL

1.1 WORK INCLUDED
A. Furnish and install all labor and materials required for the installation of a Corning fiber cable system.
B. Owner will provide all patch cords, cross connects, networking equipment, telephone and monitoring equipment. Close coordination with the owner will be required.

1.2 RELEVANT SECTIONS
A. 27 05 28 Telecommunications Pathways
B. 27 13 13 Telephone Backbone Cabling
C. 27 15 13 Category 5e Horizontal Cabling
D. 27 70 80 Cable Television Cabling

1.3 QUALITY ASSURANCE
A. Do all work in accordance with the guidelines published in EIA/TIA standard 568 and 569. Where conflicts exist, the plans and specifications shall take precedence. All manufacturer installation instructions shall be followed. Where conflicts exist between manufacturer instructions and these plans and specifications, the manufacturer instructions shall take precedence.
B. The installed system shall be covered by the Corning Cable Systems Corning Extended Warranty Program.

1.4 SUBMITTALS
A. Submit five sets of shop drawings and product data (or a greater number if specified in Division 1 “Submittals” Section). Submittals will be required for the following items.
1. Evidence that installing contractor is certified by Corning
2. All product data.
3. Rack layouts, including panels and wire management for all racks and cabinets.

1.5 GUARANTEE
A. The installed optical fiber cable system shall be covered by the Corning LANscape Extended Warranty Program. This warranty must cover each product component installed as well as the total performance of the optical fiber cable system. Corning Cable Systems shall guarantee to repair or replace defective products free of charge after installation.

PART 2 - PRODUCTS

2.1 PRODUCTS
A. Fiber optic distribution units shall be sized according to total number of fiber panels or modules installed:
1. 1 to 4 panels/modules: Corning CCS-03U with integrated splice housing
2. 4 to 12 panels/modules: Corning CCH-04U
3. Above 12 panels/modules: provide as many Corning CCH-04U as are required to accommodate the panels/modules.
B. Rack Mount Fiber Optic Splice Housing shall be sized according to the number of splice trays required.
1. 1 to 2 splice trays: no dedicated splice housing required if using Corning CCS-03U
2. 1 to 12 splice trays: Corning CSH-03U
3. 12 to 22 splice trays: Corning CSH-05U
C. All fiber cables shall be of an all dielectric construction

D. Outdoor Fiber Cable Package
   1. Cable must be warranted by the Corning for use in outdoor applications and listed for use in applications requiring a UL listing of CMR or OFNR.
   2. Cable must utilize loose buffer tube construction with no more than 12 fibers per buffer tube.
   3. Cable must be water blocked, with water swellable yarns and tapes.

E. Indoor Fiber Cable Package
   1. Cable must fire rated for use in the space it is installed.
   2. Individual fiber subunits shall consist of 900 micron tight buffer.

F. Multi Mode Fiber
   1. 62.5 micro multi mode fiber cable: Corning 62.5µm/125µm. Attenuation: 3.0 dB/km @ 850 nm; 1.5 dB/km @ 1300 nm. Minimum effective modal bandwidth: 200/500 Mhz/km.
   2. Multi mode ST fiber panels: Corning CCH-CP06-15T 6-fiber ST Panels
   3. Multi mode ST connectors: Corning 95-101-52-SP 6 2.5 micron anaerobic-cure connectors

G. Single Mode Fiber
   1. Cable: Corning SMF28 single mode fiber.
   2. 6-Fiber Single mode SC fiber modules pre-loaded with six factory SC/UPC pigtails: Corning CCH-RM06-3C-P03RH
   3. 12-Fiber Single mode SC fiber modules pre-loaded with twelve factory SC/UPS pigtails: Corning CCH-RM12-3C-P03RH.

H. Racking and Cabinets:
   1. All racking will be provided by work in other sections. No racking is specified in this section.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. The Contractor shall furnish and install all cabling in accordance with these specifications, and as indicated on the cable schedules and drawings. Corning installation specifications shall take precedence if there is a conflict with this section.

B. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical coupler installed between the cable points of origin and termination except as shown on drawings and or specifications.

C. Contractor is responsible for insuring that cable jacket is suitable for the environment in which it is placed i.e.: OFNR, OFNP rated. Unless otherwise noted on the drawings, all cable should be assumed to be rated OFNR.

D. All cable shown on drawings to be routed in conduit and cable tray system.

E. At the same time cable is pulled into a cable pathway, also install a mule tape of appropriate size to facilitate future cable pulls along those pathways.

F. Surface mounted raceway or exposed cable not specifically designated require written approval of the architect.

G. Provide fire stopping at all locations where cables penetrate fire rated surfaces. Materials and methods used shall be acceptable to the code authority having jurisdiction and shall maintain the fire integrity of the wall, floor, or ceiling.
H. Contractor shall closely coordinate and work with the owner on the construction of racking and panels and termination and routing of the cabling in the telecommunications room, overhead basket tray, and into the open relay racks and cabinets.

3.2 FIBER OPTIC CABLE INSTALLATION

A. Manufacturer instructions shall be carefully followed during the installation of fiber optic cable. Particular attention should be paid to pulling tension and bend radius.

B. At least 30ft of slack cable shall be coiled neatly and mounted to the telecommunications backboards using Velcro tie wraps in at each termination point.

C. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

D. Fiber optic splicing/distribution shall be placed at the top of the left-most rack or cabinet in the IDF when viewed from the front of the rack or cabinet unless otherwise noted on the drawings or in this specification.

E. Indoor Fiber Cable
   1. Where routed through tray system, all indoor fiber cable shall be installed in plenum rated inner duct.
   2. Inner duct is not required where cable is installed in conduit and that conduit does not contain any other than fiber optic cables. In conduits that are populated with other cabling, inner duct shall be provided and installed.

F. Outdoor Fiber Cable
   1. Each intermediate vault shall have 80ft of slack cable coiled and stored neatly.
   2. Fanout kits shall be installed on all buffer tubes containing multi mode fiber.
   3. Fanout kits are not required for single mode fiber.

G. Multi Mode Fiber Cable
   1. Multi mode fiber cable shall be terminated with ST anaerobic-cure connectors.
   2. Fiber shall be hand or machine polished according to Corning instructions.
   3. Terminated fiber shall be mounted in standard color code order into ST bulkhead panels mounted in the fiber optic enclosures.

H. Single Mode Fiber Cable
   1. Single mode fiber cable shall be terminated by fusion splicing factory SC/UPC pigtails modules onto the backbone cabling.
   2. The fiber count in the SC/UPC pigtail modules shall be matched to the fiber count in the cabling being terminated.
      a. If a cable has 6 single mode fibers, then a 6-fiber pigtail module shall be used to terminate that cable.
      b. If a cable has 12 or multiples of 12 single mode fibers, then 12-fiber pigtail modules shall be used to terminate that cable.
   3. Fiber slack of buffer tubes or indoor fiber sub-units shall be neatly coiled within the fiber splice enclosure. No slack loops of buffer tubes shall be allowed in the cabinet or on the relay rack.
   4. Each fiber cable shall be stripped to expose the 6 or 12-fiber sub units or buffer tubes upon entering the fiber splice enclosure and the sub units or buffer tubes routed to the splice tray.
   5. A maximum of 12 strands of fiber shall be spliced in each tray and no more than one cable shall be spliced in a tray, which means that some trays will only contain 6 splices.

3.3 IDENTIFICATION

A. Fiber Optic Backbone Cable Identification
OPTICAL FIBER BACKBONE CABLING

1. Each fiber optic cable shall be assigned a unique identifier consisting of the following components:
   a. Abbreviation for the originating telecommunications room. Typical originating telecommunications room is Core1 or Core 2.
   b. Abbreviation for the terminating telecommunications room. Typical terminating telecommunications room will be MDF, IDF-B, IDF-C, Warehouse IDF, etc.
   c. Fiber type: MM for multi-mode, SM for single-mode, or HY for a hybrid multi and single mode cable.
   d. Strand count. If cable is a hybrid multi and single mode cable, the multi mode strand count should be indicated first, followed by the character slash “/” followed by the single mode strand count.

2. The unique cable ID shall be constructed from these 4 components. For example, if you were labeling a hybrid 24 multi mode, 12 single mode fiber cable run from the MDF to IDF B, your cable label would be MDF-IDFB-HY-24/12.

3. Cable shall be labeled at each telecommunication room, near the location that the cable enters the fiber optic panels or splice enclosures.

4. Each splice tray shall be clearly labeled with cable ID and specific strand counts in that tray.

5. Cable shall be labeled every 50’ along the length of the cable in open trays, and on each side of all wall penetrations.

6. Cable routed in conduit systems shall be labeled at each pull point. This includes the every time cable enters or exits a conduit, j-box, or pull vault.

7. Fiber optic panels shall be labeled with the destination of the fiber cable, the fiber type, the strand number within the cable.

3.4 IDF ROOMS

A. Construction of the backboards, overhead ladder racking, open relay racks, and server cabinets is specified in other sections and is not included in work specified in this section.

B. In all IDFs, the fiber optic cable shall be routed onto overhead ladder racking systems. The installation shall be coordinated with work by others.

C. Fiber optic slack loops shall be placed in out of the way locations on the walls. Slack loops shall not be placed on the overhead ladder racking, open relay racks, or server cabinets.

D. The sections that specify the work of installing the open relay racks in IDF rooms has stipulated that space at the top of the left most rack is to be reserved for fiber optic enclosures that will be installed as work specified in this section. Close coordination with the contractor installing the open relay racks is required.

3.5 TERMINATION HARDWARE

A. Quantities of termination blocks, racks, splice enclosures, and patch panels, etc. shown on drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of termination hardware required to terminate the volume of cable described herein and shown on the drawings.

3.6 CROSS-CONNECT

A. The owner will perform all cross-connects and patching unless otherwise noted.

3.7 CABLE TESTING

A. General
   1. Provide 48 hour advance notice of testing.
   2. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
OPTICAL FIBER BACKBONE CABLING

3. Conduct cable testing as described below upon completion of installation. Test fully completed systems only.

4. Remove all defective cables from pathways system. Do not abandon cables in place.

5. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.

6. The Engineer further reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent (5%) of the cable plant to confirm documented test results.

7. All test results and corrective procedures are to be documented and submitted with the as-built drawings.

B. Fiber Optic Cable Testing

1. After all terminations have been completed, tests will be conducted using an OTDR prior to loss testing. Contractor will OTDR all fibers in both directions. OTDR testing will verify proper installation of the cable, splices, and connectors and will establish the length of the cable to be used during acceptance.

2. After OTDR testing on a span is complete, contractor shall then perform loss testing at two wavelengths specified below. Loss tests shall be recorded for each fiber for each wavelength. These values shall be used to perform acceptance calculations described below.

   a. Multi Mode fiber wavelength testing shall be at 850nm and 1310nm.

   b. Single Mode fiber wavelength testing shall be at 1310nm and 1550nm.

3. Contractor shall perform span loss calculations to compute the maximum allowed loss for each span at each wavelength. These span loss calculations shall be compared to measured performance. Span loss shall be calculated based on manufacturer guaranteed performance at the measured wavelength adjusted by the length of the cable. To that figure, span loss shall add .5dB for each mated connector and .25dB for each fusion splice. This figure is the maximum loss at that wavelength that is allowed for the cable span.

4. A fiber cable is accepted when the measured loss in all fiber strands in the cable less than the calculated span loss.

5. Cables that are not accepted will be removed and replaced at the contractors expense.

3.8 ACCEPTANCE

A. Upon receipt of the Contractor’s documentation of cable testing, the Engineer will review the installation and may request a test in his presence, of up to 1% of the cables/wires installed.

3.9 AS-BUILT DOCUMENTATION

A. As built documentation shall include 3 copies of the following:

   1. Annotated CAD prints and disks of the electrical set of prints indicating routes of installed cables, slack loop locations, and termination points.

   2. All test results both in machine readable format as well as printed neatly bound and organized. Each test shall clearly indicate cable and fiber strand designations.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED
A. Furnish and install all labor and materials required for the installation of PANDUIT® Augmented Category 6 cabling shown on the drawings. This backbone cabling system will provide connectivity from the MDF to individual IDFs.
B. Unless otherwise noted, owner will provide all patch cords, cross connects, networking equipment, telephone and monitoring equipment. Close coordination with the owner will be required.
C. The scope of this work includes coordination with the division 28 access control and CCTV security contractors who may need to place UTP cable and patch panels in open relay racks in the IDF.

1.2 RELEVANT SECTIONS
A. 27 05 28 Telecommunications Pathways
B. 27 13 13 Telephone Backbone Cabling
C. 27 13 23 Optical Fiber Backbone Cabling
D. 27 70 80 Cable Television Cabling

1.3 QUALITY ASSURANCE
A. Do all work in accordance with the guidelines published in EIA/TIA standard 568 and 569. Where conflicts exist, the plans and specifications shall take precedence. All manufacturer installation instructions shall be followed.
B. Horizontal cabling system shall be provided with a one year system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of at least 1 year and will include all labor and materials to correct any defect during the warranty period.
C. The contractor shall have completed Panduit product and installation training.

1.4 SUBMITTALS
A. Submit five sets of shop drawings and product data (or a greater number if specified in Division 1 “Submittals” Section). Submitalls will be required for the following items.
1. All product data.
3. Rack layouts, including panels and wire management for all racks.

1.5 GUARANTEE
A. The Category 6A Backbone Cabling system shall be provided with a one year system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of at least 1 year and will include all labor and materials to correct any defect during the warranty period.

PART 2 - PRODUCTS

2.1 PRODUCTS
A. Category 6A unshielded twisted pair cable: any cable warranted by manufacturer to support 10 Gigabit applications. Cable jacket shall be blue in color.
B. Category 6A patch panels: Panduit CPPL24WBLY mini-com 24 port patch panels loaded with mini-com TX6A 10Gig jacks, black in color.

C. Relay rack horizontal wire management: Panduit WMPF2E 2 position wire management panel.

PART 3 - EXECUTION

3.1 GENERAL CABLE INSTALLATION

A. The Contractor shall furnish and install all cabling in accordance with these specifications, and as indicated on the cable schedules and drawings.

B. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical coupler installed between the cable points of origin and termination except as shown on drawings and or specifications.

C. Contractor is responsible for insuring that cable jacket is suitable for the environment in which it is placed i.e.: CM, CMR, CMP rated.

D. All cable shown on drawings to be routed in conduit and cable tray system, where provided.

E. At the same time cable is pulled into a cable pathway, also install a pull string of appropriate size to facilitate future cable pulls along those pathways.

F. Surface mounted raceway or exposed cable not specifically designated require written approval of the architect.

G. Provide fire stopping at all locations where cables penetrate fire rated surfaces. Materials and methods used shall be acceptable to the code authority having jurisdiction and shall maintain the fire integrity of the wall, floor, or ceiling.

H. Contractor shall closely coordinate and work with the owner on the construction of racking and panels and termination and routing of the cabling in the telecommunications room, overhead basket tray, and into the open relay racks.

I. Unless otherwise specified in the drawings, each IDF shall be served by 12 category 6A cables from the MDF.

J. No installed category 6A cable shall exceed 90 meters in length.

K. The contractor will be responsible for the installation of all "J-hooks" for horizontal cable support. Coordinate location of support hardware to avoid conflicts with other trades. All support hardware shall be category 5e compliant, which means that D-rings and bridle rings are not allowed.

L. Cabling shall be secured to the "J-hooks" and cable basket tray using Velcro wraps. The Velcro wraps will be cinched snug enough around the cable bundle to keep them uniform and routed neatly through the hooks or basket tray, but not so tight as to damage the cables themselves.

M. Where conduit is not provided, cable shall be bundled neatly and attached securely to building structure at intervals not to exceed 5 feet. Cable shall not be attached to conduit, ducting, or piping. It shall not be allowed to drape over building elements.

N. The category 6A cabling in the racks shall be installed with sufficient and appropriate rear mounting clips, brackets, and rear cable management to provide a secure and maintainable system.

O. Horizontal front facing wire management panels are to be two position finger duct. A single wire management panel must be installed facing the front of the racks at the top position in the rack and under each patch panel. Thus, there is to be one more wire management panel than patch panel.

P. In each IDF, space at the top of the left most rack shall be reserved for a fiber optic enclosure that will be installed under work specified in other sections.
Q. The category 6A backbone cable shall be installed into patch panels that are installed under the fiber optic enclosure referenced in the above item.

R. Only category 6A backbone cabling shall be installed in the category 6A backbone patch panels. These panels shall be dedicated to backbone cabling use and not used for category 5e horizontal cabling.

S. Unless specifically directed by the owner, relay racks shall be filled from top to bottom, left to right. No IDF relay rack shall be filled with more than 22 RU of patch panels and wire management. The bottom 20RU of each IDF rack is reserved for use by the owner.

3.2 IDENTIFICATION

A. Category 6A backbone cable identification:
   1. Each category 6A backbone cable shall be assigned a unique cable ID that is constructed out of the following components:
      a. The IDF identification that the cable terminates in (IDF-B, IDF-C, etc.).
      b. A 3-digit cable number. Each category 6A cable pulled to an IDF shall be number sequentially starting at 001 and increasing for each cable pulled to that IDF.
   2. For example, the label for the 12th cable run to from the MDF to IDF B shall have cable ID IDF-B-012.

B. Patch Panel Identification
   1. Above each set of jacks shall be a label indicating where the cabling runs to. If the cabling is run from the MDF to IDF-B, then the patch panel in the MDF shall be labeled “To IDF-B” and in IDF-B, the panel shall be labeled “To MDF”
   2. Below each jack in every patch panel, the 3-digit cable number representing that jack. All cable numbers in all patch panels must be sequential.
   3. Label shall be typewritten label tape, 3/8 inch wide with industrial strength adhesive.

3.3 TERMINATION HARDWARE

A. Quantities of termination blocks, racks, splice enclosures, and patch panels, etc. shown on drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of termination hardware required to terminate the volume of cable described herein and shown on the drawings.

3.4 CROSS-CONNECT

A. The owner will perform all cross-connects and patching unless otherwise noted.

3.5 CABLE TESTING

A. General
   1. Provide 48 hour advance notice of testing.
   2. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
   3. Conduct cable testing as described below upon completion of installation. Test fully completed systems only.
   4. Remove all defective cables from pathways system. Do not abandon cables in place.
   5. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.
   6. The Engineer further reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent (5%) of the cable plant to confirm documented test results.
   7. All test results and corrective procedures are to be documented and submitted with the as-built drawings.

B. Category 6A cable:
   1. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
CATEGORY 6A BACKBONE CABLING

2. All category 6A cables shall be tested and certified to support 10GbaseT Gigabit Ethernet.

3.6 ACCEPTANCE

A. Upon receipt of the Contractor's documentation of cable testing, the Engineer will review the installation and may request a test in his presence, of up to 1% of the cables installed.

3.7 AS-BUILT DOCUMENTATION

A. The contractor shall provide CAD prints and disks of the electrical set of prints indicating final faceplate location, faceplate designations, rack designations, as well as major conduit, cable tray, and installed cable routes.

B. The contractor shall include machine readable results of all test results neatly bound and organized. Each test shall clearly indicate jack and/or cable designations.

END OF SECTION
PART 1 - GENERAL

1.1 WORK INCLUDED
A. Furnish and install all labor and materials required for the installation of a PANDUIT category 5e cabling system. This horizontal cabling system will provide connectivity from each IDF to indicated station outlets, and provide and install all open relay racks and overhead ladder racking in the IDFs.

B. Work described in this section includes all open relay racks in all IDF rooms, all overhead ladder racking for cable routing and support inside all IDF rooms.

C. Unless otherwise noted, owner will provide all patch cords, cross connects, networking equipment, telephone and monitoring equipment. Close coordination with the owner will be required.

D. The scope of this work includes coordination with the division 28 access control and CCTV security contractors who may need to place UTP cable and patch panels in open relay racks in the IDF.

1.2 RELEVANT SECTIONS
A. 27 05 28 Telecommunications Pathways
B. 27 13 13 Telephone Backbone Cabling
C. 27 13 23 Optical Fiber Backbone Cabling
D. 27 13 33 Category 6A Backbone Cabling
E. 27 70 80 Cable Television Cabling

1.3 QUALITY ASSURANCE
A. Do all work in accordance with the guidelines published in EIA/TIA standard 568 and 569. Where conflicts exist, the plans and specifications shall take precedence. All manufacturer installation instructions shall be followed.

B. Horizontal cabling system shall be provided with a one year system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of at least 1 year and will include all labor and materials to correct any defect during the warranty period.

C. The contractor shall have completed Panduit product and installation training. All workers involved in the installation and termination of cable shall have at least one year of experience. No less than 33% of the workmen on the job shall have attended a vendor sponsored training program covering installation and termination of cable.

1.4 SUBMITTALS
A. Submit five sets of shop drawings and product data (or a greater number if specified in Division 1 “Submittals” Section). Submittals will be required for the following items.
1. All product data.
3. Rack layouts, including panels and wire management for all racks.

1.5 GUARANTEE
A. Horizontal cabling system shall be provided with a one year system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling
PART 2 - PRODUCTS

2.1 PRODUCTS

A. Horizontal Cabling:
1. Category 5e unshielded twisted pair cable: any manufacturer extra headroom (300+ Mhz) category 5e cable. Cable jacket shall be blue in color.
2. Category 5e Station Jacks: Panduit mini-com TX5e jacks CJ5E88TGXX, color to match electrical outlet color.
3. Single gang device plates: Panduit mini-com CFPnXX classic series device plates or CFPnSY for stainless steel device plates, number of jack positions as required. Match color and style of electrical trim.
4. Modular Furniture device plates: Panduit mini-com appropriate for modular furniture yet to be selected. This is a coordination issue. Bid shall include modular furniture device plates.
5. Category 5e patch panels: Panduit CPPL48WBLY mini-com 48 port patch panels loaded with mini-com TX5e jacks, black in color.
6. Special alarm and emergency dial tone IDF termination hardware: 110 blocks with legs, terminations with C4 block connectors

B. Wireless Access Point Horizontal Cabling:
1. See 2.1 A. and B. for materials with the following exception:
   a. Station termination: Panduit 2-port surface mount housing for above ceiling applications and 2-port single gang device plate for terminations in finished walls.
   b. Category 5e Station Jacks: Panduit mini-com TX5e jacks.

C. Security Panels, Building Automation and Power Meter Horizontal Cabling:
1. See 2.1 A. and B. for materials with the following exception:
   a. All cables shall be terminated within the enclosure that serves each BAS or metering data connection.
   b. Station Termination: Utilize Panduit CBXJ2EI-A surface mount box.

D. Security Cameras:
1. See 2.1 A. and B. for materials.
2. For grid ceiling mount cameras: Utilize Panduit CBXJ2EI-A surface mount box attached to closest building structure.
3. For wall mount cameras: Utilize appropriate deep electrical box for camera type.

E. IDF Racks and Ladder Rack:
1. Relay Racks: Chatsworth/CPI 55053-703 7ft relay racks
5. Cable Runway Radius Drop: Chatsworth/CPI 12100-7XX cross member runway radius drop and Chatsworth/CPI 12101-701 string runway radius drop.
6. Cable Retaining Post: Chatsworth/CPI 10596-706 6” retaining post and 10596-708 8” retaining Post
7. Mounting hardware, splices, grounding kits, and support brackets: Chatsworth/CPI
C. Contractor is responsible for insuring that cable jacket is suitable for the environment in which it is placed i.e.: CM, CMR, CMP rated.

D. All cable shown on drawings to be routed in conduit and cable tray system, where provided.

E. At the same time cable is pulled into a cable pathway, also install a pull string of appropriate size to facilitate future cable pulls along those pathways.

F. Surface mounted raceway or exposed cable not specifically designated require written approval of the architect.

G. Provide fire stopping at all locations where cables penetrate fire rated surfaces. Materials and methods used shall be acceptable to the code authority having jurisdiction and shall maintain the fire integrity of the wall, floor, or ceiling.

H. Contractor shall closely coordinate and work with the owner on the construction of racking and panels and termination and routing of the cabling in the telecommunications room, overhead basket tray, and into the open relay racks.

3.2 HORIZONTAL CATEGORY 5E CABLE INSTALLATION

A. Unless otherwise specified, each station outlet shall consist of four (4) category 5e cables. Four port device plates shall be loaded with four jacks.

B. No installed category 5e cable shall exceed 90 meters in length.

C. All cables shall be terminated in station jacks, no direct RJ-45 or RJ-11 connections are allowed.

D. The contractor will be responsible for the installation of all "J-hooks" for horizontal cable support. Coordinate location of support hardware to avoid conflicts with other trades. All support hardware shall be category 5e compliant, which means that D-rings and bridle rings are not allowed.

E. Cabling shall be secured to the “J-hooks” and cable basket tray using Velcro wraps. The Velcro wraps will be cinched snug enough around the cable bundle to keep them uniform and routed neatly through the hooks or basket tray, but not so tight as to damage the cables themselves.

F. Where conduit is not provided, cable shall be bundled neatly and attached securely to building structure at intervals not to exceed 5 feet. Cable shall not be attached to conduit, ducting, or piping. It shall not be allowed to drape over building elements.

G. Cabling shall be installed with a 15ft slack loop placed as near to the station outlet as possible. Often this slack loop will be in the cable tray or above a drop ceiling where conduit is stubbed from the outlet box.

H. The scope of this work includes installation of workstation cables into modular furniture systems. These systems have not yet been specified, so bid should be based on quantities of jacks shown on drawings. The actual installation shall be coordinated with the modular furniture system contractor. This includes assisting in planning cable routes into the furniture systems, selecting appropriate device plates for the furniture system, selecting appropriate outlet locations, and installing the cabling into the furniture systems at the appropriate time during the furniture system installation. Prior to the furniture system installation, the workstation cables will be pulled near the entrances to the furniture systems. The cabling shall be pulled with sufficient slack to reach the outlet location. This slack left coiled in a location where it will not be
susceptible to damage. After the modular furniture systems are installed, the contractor will pull
cable to the outlet locations and complete the cable installation. As of the date of the bid set of
construction drawings, the modular furniture plan is not complete. Drawings are representative
only and should be used to bid quantities of cabling and outlets. The drawings do not reflect
actual outlet locations.

I. Installation of communications cabling into floor boxes shall be coordinated with the electrical
sub contractor. Provide and install appropriate device plates for mounting the jacks in the
electrical contractor installed floor boxes.

J. Installation and termination of communications cabling will require coordination with the cable
television cabling work specified in 27 70 80. Coordinate cable pulls and communications
device plates with this work.

K. The category 5e cabling in the racks shall be installed with sufficient and appropriate rear
mounting clips, brackets, and rear cable management to provide a secure and maintainable
system.

L. Unless otherwise noted below, the category 5e cabling shall be terminated in category 5e jacks
that are mounted into category 5e patch panels. All cables run to a single station device plate
shall be terminated on sequential jacks in the patch panels.

M. Horizontal front facing wire management panels are to be two position finger duct. A single wire
management panel must be installed facing the front of the racks at the top position in the rack
and under each patch panel. Thus, there is to be one more wire management panel than patch
panel.

N. In each IDF, space at the top of the left most rack shall be reserved for a fiber optic enclosure
that will be installed under work specified in other sections. Rack layout shall be coordinated
with this work.

O. Unless specifically directed by the owner, relay racks shall be filled from top to bottom, left to
right. No IDF relay rack shall be filled with more than 22 RU of patch panels and wire
management. The bottom 20RU of each IDF rack is reserved for use by the owner.

P. Wall phone wiring: All outlets for wall phones are to meet ADA height and location requirements
for handicapped access. For specifically identified wall phone locations, a single voice outlet
shall be installed to provide voice-only communication. Two category 5e cables shall be pulled
to each location. At the station end, one cable shall be tagged and coiled for future use and the
other cable shall be terminated in a single category 5e jack and the jack mounted into a
stainless steel wall phone plate. Both of the category 5e cables pulled to a wall phone location
shall be terminated on the IDF end in the category 5e patch panel system.

Q. Pay Phone wiring: All outlets for pay phones are to meet “American Disabilities Act” (ADA)
height and location requirements for handicapped access. A single voice outlet shall be
installed to provide voice-only communication. Two category 5e cables shall be pulled to each location. All pay phone cabling shall be terminated at the station end in a duplex device plate with jacks blue and gray in and in the IDF end on wall-mount 110-style punch blocks.

R. Elevator wiring: For each elevator location, a duplex outlet shall be installed to provide voice-
only communication. Two category 5e cables shall be pulled to each location. All elevator
cabling shall be terminated in the IDF on wall-mount 110-style punch blocks. Installation of
elevator system jacks shall be coordinated with the elevator installer. Provide cross connects to
extend elevator dial tone from the telephone service entrance blocks to telephone backbone
cabling, and then onto to this cabling.

S. Fire and Security Alarm wiring: For each alarm location, a duplex outlet shall be installed to
provide voice-only communication. Two category 5e cables shall be pulled to each location. All
fire and security voice cabling shall be terminated in the IDF on wall-mount 110-style punch
blocks. Installation of alarm system jacks shall be coordinated with the alarm installer.
**CATEGORY 5E HORIZONTAL CABLING**

cross connects to extend elevator dial tone from the telephone service entrance blocks to telephone backbone cabling, and then onto to this cabling. **Network cabling shall be terminated as described in Section 3.2 T., coordinate with owner and alarm contractor for specific cable count.**

**T.** Building Automation and Power metering wiring: For each monitoring location a duplex outlet shall be installed **to provide communication.** They shall be in the enclosure housing the BAS and metering applications. No active networking devices are allowed in the BAS and Power metering system. All devices shall be connected via structured cabling to the closest data closet and are to be directly connected to the University operations network.

**T-U. Security Camera wiring:** For each camera a duplex outlet shall be installed and terminated as specified in 2.1 A. 2. For cameras mounted to ceiling grid a surface mount box shall be utilized and affixed to the nearest stable location. For wall mount cameras terminate the cables in the box **JH2** utilized as the camera mount, see 3.4 B. 4. for identification.

**U-V.** The scope of this work includes coordination with the contractor installing the cable TV system. This coordination requires coordination of cable pulls and device plates where TV outlets share conduit and/or device plates with cable TV.

### 3.3 WIRELESS ACCESS POINT CATEGORY 5E CABLE INSTALLATION

- **A.** Please refer to specifications outlined in the above Horizontal category 5e cable installation section.
- **B.** Unless otherwise specified, each wireless access station outlet shall consist of two (2) category 5e cables.
- **C.** Where the wireless access point station termination point is above the drop ceiling, the station outlet shall be terminated in a two port surface housing that is attached to the building structure or basket tray.
- **D.** Where the wireless access point station termination is on a wall, it shall be mounted in a standard two port single gang device plate.
- **E.** The wireless access point category 5e cabling shall be terminated on the category 5e patch panel system.

### 3.4 IDENTIFICATION

- **A.** Horizontal cable identification:
  1. Each category 5e cable shall be assigned a unique cable ID that is constructed out of the following components:
     a. The three digit building number.
     b. The IDF identification that the cable terminates in.
     c. A 4-digit cable number. Each cable pulled to an IDF shall be number sequentially starting at 001 and increasing for each cable pulled to that IDF.
  2. For example, the label for the 92nd cable run to IDF B in building 33 shall have cable ID 033B0092. The building number for this project is 33.

- **A.** Horizontal cable identification:
  1. Each category 5e cable shall be assigned a unique cable ID that is constructed out of the following components:
     a. The three digit building number.
     b. The IDF identification that the cable terminates in.
     c. A 4-digit cable number. Each cable pulled to an IDF shall be number sequentially starting at 001 and increasing for each cable pulled to that IDF.
  2. For example, the label for the 92nd cable run to IDF B in building 16 shall have cable ID 016B0092.
3. Each cable shall be identified with a typewritten cable tag containing the cable ID that shall be placed on both ends of all cables, 6 inches from the connector and/or termination blocks. Each label shall be created using a label maker appropriate for cable installation. Hand written cable labels are not acceptable.

B. Device Plate identification
1. Each device plate shall be labeled as follows:
   a. At the top of the device plate, the building number and IDF letter (for example, every device plate with conductors run to IDF B in building 33 shall have 033B at the top of the device plate).
   b. Under each individual jack, the 4-digit cable number.
2. All jacks in a single device plate must have sequential cable numbers.
3. Device plate labeling shall be typewritten label tape with industrial strength adhesive.
4. For cables that are not terminated in device faceplate or surface mount box, identification with a label equivalent to horizontal cable identification described in 3.04 A. 1. shall suffice.

C. Patch Panel Identification
1. Each group of four sequential jacks representing a typical device plate in the category 5e panels must be labeled with the room number of that the device plate resides in. This room number must be the permanent room numbers assigned by the owner, not the construction room numbers. The room designation shall be placed above the jacks in the panel.
2. Below each jack in every patch panel, the 4-digit cable number representing that jack. All cable numbers in all patch panels must be sequential.
3. Label shall be typewritten label tape, 3/8 inch wide with industrial strength adhesive.

D. Security Camera Identification
1. Each security camera shall have a unique identifier label (ie: Camera1, Camera 2, etc) that is visible from the outside. See above section A for cable identification.

E. 110-Block Identification
1. Each 4-pair position on the special horizontal cable 110 blocks shall be labeled with the cable ID and the function (elevator, fire alarm, etc) on the 110 designation strip.

3.5 IDF AND SERVICE ENTRANCE ROOMS
A. Backboards are specified in other sections and will be provided and installed by others.
B. Drawings indicate number of racks to install in each IDF and provide a diagrammatic view of the overhead ladder racking. The drawings are diagrammatic only and are not necessarily indicative of the amount of overhead ladder racking that will be required to support the cabling from where it enters the room and is routed to the open relay racks. The scope of this work includes installing any and all overhead ladder racking to support all voice/data cabling that is routed inside of each IDF.
C. Contractor is responsible for providing earthquake bracing and support for all racks installed in telecommunications rooms.
D. Each relay rack must have front facing vertical wire management chases installed on each side of the rack.
E. Racks shall be firmly fastened to the floor and have overhead ladder rack run from the top of the each rack to the wall at the rear of the rack.
F. Each IDF shall have space reserved in the top left most rack for fiber optic enclosures that are specified in other sections.
G. Relay racks shall be filled from top to bottom, left to right. No IDF relay rack shall be filled with more than 22 RU of patch panels and wire management. The bottom 20RU of each IDF rack is reserved for use by the owner.
CATEGORY 5E HORIZONTAL CABLING

H. Contractor shall install overhead ladder racking to provide bracing as well as pathway to support and route all cabling to racks in low voltage and telecommunication rooms. The overhead ladder racking shown on drawings is illustrative only and is meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of ladder racking hardware required to support the cabling described herein and shown on the drawings.

I. Overhead ladder racking must be installed to provide sufficient pathways to route limited energy cabling in the IDF rooms. Drawings are schematic design only and do not necessarily indicate the size, routing, or amount of ladder racking required to support all installed cabling. Size as needed; minimum size 18 inches. Category 5e bend radius shall be maintained by avoiding sharp corners where tray joins together at right angles as well as routing cable properly out of the tray and onto the relay racks using radius runway drops. Cable retaining posts shall be installed where needed to dress cable to the overhead ladder racking. When used, posts shall be installed with spacing no greater than 18”.

3.6 TERMINATION HARDWARE

A. Quantities of termination blocks, racks, splice enclosures, and patch panels, etc. shown on drawings are illustrative only and are meant to indicate the general configuration of the work. The Contractor is responsible for providing the correct quantities of termination hardware required to terminate the volume of cable described herein and shown on the drawings.

3.7 CROSS-CONNECT

A. The owner will perform all cross-connects and patching unless otherwise noted.

3.8 GROUNDING

A. Furnish and install a telecommunications grounding system. This grounding system shall consist of a main ground busbar in the service entrance location and a ground busbar installed in each of the telecommunications rooms in the project.

B. The ground busbar shall be mounted on the IDF backboard.

C. A 2AWG insulated conductor shall be run from the main grounding busbar to each of the ground busbars in each telecommunications room. Conductor insulation shall be green in color.

D. All metallic cable tray, ladder rack, raceways, cable sheath/armor, enclosures, and equipment racks and other conductive surfaces shall be properly bonded with 5eWG insulated conductors to the grounding system. All paint and other coatings shall be removed at all contact surfaces to ensure proper ground.

E. All grounding shall be in compliance with the NEC code Article 800, Article 250, well as EIA/TIA standard 607.

3.9 CABLE TESTING

A. General

1. Provide 48 hour advance notice of testing.
2. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
3. Conduct cable testing as described below upon completion of installation. Test fully completed systems only.
4. Remove all defective cables from pathways system. Do not abandon cables in place.
5. The Engineer reserves the right to observe the conduct of any or all portions of the testing process.
6. The Engineer further reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent (5%) of the cable plant to confirm documented test results.
CATEGORY 5E HORIZONTAL CABLING

7. All test results and corrective procedures are to be documented and submitted with the as-built drawings.

B. Category 5e cable:
   1. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
   2. All category 5e cables shall be tested and certified to support 1000baseT Gigabit Ethernet.

3.10 ACCEPTANCE

A. Upon receipt of the Contractor's documentation of cable testing, the Engineer will review the installation and may request a test in his presence, of up to 1% of the cables installed.

3.11 AS-BUILT DOCUMENTATION

A. The contractor shall provide CAD prints and disks of the electrical set of prints indicating final faceplate location, faceplate designations, rack designations, as well as major conduit, cable tray, and installed cable routes.

B. The contractor shall provide 3 copies of all test results neatly bound and organized. Each test shall clearly indicate jack and/or cable designations.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing Basics: Drawings and general provisions of Contract, including Revised General Conditions, Special Conditions and other Division 01 Specification sections apply to this section.

1.2 SUMMARY

A. Content: Various audio and video systems, equipment and installation includes, but is not limited to:
   1. Conference Rooms
   2. Auditorium
   3. Information Displays
   4. PA Systems
   5. Outdoor AV Interconnectivity
   6. Radio Studio Interconnectivity

B. Nomenclature: The systems shall be called the “sound system”, “audio/visual system”, “sound field system” and the installer the “AV system installer” or “AV contractor”.

C. Equipment:
   1. Audio Mixers, Equalizers, Amplifiers, Program Sources, and other audio processing equipment.
   2. Loudspeakers, custom coated enclosures and speaker mounting or support hardware including speaker mounting frames and incidental steel support members.
   3. Video Projectors and associated routing and switching equipment.
   4. Equipment Racks and portable cabinets.
   5. Control Equipment, remote power switching
   6. Cables, connectors, plates and wiring.

D. Related Sections: Division 01 and applicable Sections under Division 26.

1.3 REFERENCES:

A. Sound System Engineering (2nd Edition), Davis and Davis, Howard W Sams, 1987
B. Audio system – Design and Installation, Giddings, Howard W Sams, 1990
C. ANSI S4.48-1992
D. EIA Standard RS-160
E. EIA Standard RS-219
1.4 SUBMITTALS

A. Comply with Section 01 33 00, unless otherwise indicated.

B. Provide simultaneously thirty (30) days after issuance of Notice to Proceed.

C. Complete schedule of submittals.
   1. Chronological schedule: of Work in bar chart form (using Microsoft Project or similar program). Revise and resubmit schedule as required to reflect construction progress.
   2. Product Data Sheets: Provide a complete list in spreadsheet format (along with manufacturer’s data sheets) on products to be incorporated within the Work. Arrange data sheets in specification order per system. Approval of Product Data Sheets is required prior to ordering any equipment.
      a. Submit (3) three bound originals of manufacturers’ product technical data for each product in sufficient detail to facilitate proper evaluation of product suitability for incorporation in the Work.
      b. Provide tab dividers for each group of data sheets, arrange each section in alphabetical order.
   3. Shop Drawings:
      a. Shop drawings are to be prepared in the current version of AutoCAD and submitted 30 days after submittal sheets. Subsequent revisions and Project Record Drawings are also to be generated in the current version of AutoCAD. AutoCAD 2010 or later
      b. Installation: Special details depicting methods and means specific to each product, assembly and each product manufacturers recommended installation methods and means.
      c. Schematic: Detailed, redrawn wiring diagrams for each system, including cable types, identification and color codes, and detailed wiring of connections and terminal strips.
      d. Floor Plans: Drawn to scale of not less than 1/8’’ = 1’-0” Show AV Systems devices including wall and ceiling mounted speakers, wall and floor panels/plates, junction boxes, and terminal strip locations.
      e. Control: Detailed wiring diagrams including pin-outs and component lists Include color codes and cable types.
      f. Equipment: Location of Equipment in racks, consoles, tables, or cabinets, with dimensions. Wire routing and cabling within housings, AC power and terminal strip locations.
      g. Custom Enclosure and/or Millwork: Full fabrication details indicating size, material, finish, and openings for equipment.
      h. Speaker Mounting Details: Retain services of registered professional structural engineer, licensed to practice in the state of Oregon to review and develop mounting details. Structural information to include design calculations and copy
INTEGRATED AUDIO VISUAL SYSTEMS

of engineer’s certification stamp. Loudspeaker location, orientation, and support systems shall be shown.

i. Labeling: Include representative equipment and cabling labeling scheme.

j. Include any other pertinent information generated which is necessary to provide the Work.

k. Develop a test report form to be used during the Contractor’s Testing Procedures described in Part 3. Submit this form for approval as part of submittal package 30 days after notice to proceed.

D. Submit three bound original sets of the following Project Record Manual information after substantial completion and prior to final inspection.

1. On the cover of the bound original provide the project name, year and month of substantial completion, name of contractor, address of contractor, phone number for obtaining service in the event of failure and the official end date of the system warranty.

2. Product Data: Product actually incorporated within the Work, including manufacturers’ data sheet and owner’s manual for each product. Include a complete list of all equipment with serial numbers of all products.

3. Record Drawings: Final rendition of drawings depicting the actual installed system.

4. Test Reports, as described in the Test section and approved as part of the submittal documents.

5. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.

6. Service and Maintenance Manual: Provide an original copy of the service manual on every piece of equipment for which the manufacturer offers such a manual. Include phone numbers and hours of operation for all manufacturers.

7. Warranty Manual: Include manufacturer’s warranty statements, date of substantial completion and ending dates for warranties for each type of product, plus any other pertinent data required for future maintenance.

E. Project/Site Conditions:

1. Verify All Conditions At Jobsite. Promptly report variations and obstructions to the AV Consultant. All additions or corrections are to be requested prior to fabrication.

2. Field measurements shall be taken by the AV Contractor prior to preparation of shop drawings to ensure proper fitting of work. Allow for adjustments during installation whenever taking field measurements.

1.5 QUALITY ASSURANCE

A. The pre-qualified list of AV Contractors is as follows (in no particular order). All other firms wishing to submit must be approved by Listen Acoustics:

1. Delta AV
2. CompView
3. Cascade Sound
INTEGRATED AUDIO VISUAL SYSTEMS

4. AVI-SPL

B. AV Contractor must be experienced in installation of systems with similar complexity as those required for this project. The AV Contractor must have at least five years’ experience with the equipment and systems specified, must install audio/visual systems as at least 80% of their overall business, and must be able to document relevant experience with projects of similar scope installed within the past five years.

C. Installers Qualifications: Any AV Contractor who wishes to bid must submit qualification information to the Architect and AV Consultant at least (14) fourteen days prior to the bid date. Proposal must include:

1. Names of individuals holding in excess of 33-1/3% of stock in the firm, and individuals, partnerships, or corporations with which the firm is affiliated in co-ventureships or joint ventures.

2. List of not less than 10 projects of similar size and scope completed within the past five years. AV Contractor shall indicate responsibilities (engineering, shop drawings, fabrication, etc.). Furnish recent contact name, address, and phone number for each project.

3. List of current projects and approximate contract value and completion dates. Include list of names, phone numbers and addressed of owner, owners representatives, and architect. Include list of personnel who are actively involved in the current projects.

4. Provide proof of bonding capacity for an amount equal to this project. Include list of other bonded projects coinciding with this project.

5. Evidence of ability to undertake custom product engineering to meet the specific requirements of the project specifications. Provide sample project engineering drawings for custom products and contact information for facility operators where those products have been installed.

6. Project Manager and Staff: the AV Contractor must provide the name, title, and resume of the project manager and assigned staff for the Project. The project manager shall not be changed without written consent of the Owner.

7. The AV Contractor must be a franchised dealer and authorized service center for the major products specified (or provide acceptable documentation as to how products will be acquired and serviced).

1.6 DELIVERY HANDLING AND STORAGE

A. Delivery: Deliver products in original unopened packaging with legible manufacturer’s identification.

B. Storage and Protection: Comply with manufacturers recommendations. Store in a cool, dry place, out of direct sunlight, and protect from damage. Provide protective covering during installation to prevent damage from dust or other foreign materials. For products not currently installed provide secure locked storage both on site and at the AV Contractors own facility.
1.7 WARRANTY

A. In addition to manufacturers’ warranties, the AV Contractor shall warrant all equipment to be free of defects in materials and workmanship for not less than one year after date of Substantial Completion. Defects occurring in labor or materials within the warranty period shall be rectified by replacement or repair within 24 hours (if parts require longer periods to obtain, provide substitute equipment during the intervening period). Provide response to service calls and requests for information within 24 hours.

B. AV Contractor to provide Owner with exact beginning and ending dates of the warranty period, include the name and phone of the contact person as well as the procedure for obtaining service.

C. Preventive Maintenance: At six months after system acceptance, and 30 days prior to the end of the warranty, provide a complete checkout of system components. Repair or replace defective equipment, and correct any wiring or functional problems reported by the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Refer to Division 01.

B. Model numbers and manufacturers included in this specification are listed as a standard of quality. Other qualified manufacturer’s products will be considered subject to submission and approval of complete technical data, samples and results of laboratory tests, in accordance with Division 01. Substitutions will only be accepted if, in the opinion of the AV Consultant, the product is an equal to the specified product. No substitutions may be made without written acceptance from the AV Consultant. All substitutions made prior to this acceptance are at the sole risk of the AV Contractor. Substitution requests need to be submitted no less that (14) fourteen days prior to the bid date.

C. See Attachment “A” for the specific equipment list for each area. The equipment list and drawings are representative of the design and do not necessarily provide all equipment and detail for a fully functioning system. It is the responsibility of the AV Contractor to ensure the system is complete and functions according to the system descriptions and design intent.

D. For bids to be considered complete and qualified they must be bid per the documents and specifications. If proposed system includes equipment other than that specified, submit a list of major items and quantities, with a one-line schematic diagram for review and approval. Include a list of previously installed projects with similar equipment included. This list is to be submitted as an alternate to the actual bid document.

2.2 GENERAL

A. Provide new equipment and materials which conform with applicable UL, SCA, or ANSI provisions.

B. Regardless of the length or completeness of the product description in this specification, each device shall meet the published manufacturer’s specifications. Verify performance as required.
INTEGRATED AUDIO VISUAL SYSTEMS

C. Cable and Wire: The highest quality, lowest signal degradation cable and wire shall be used for the project. Shown below are typical cable and wire types. AV Contractor shall submit wire and cable types for approval prior to wire pull.
   1. Microphone: (AM) Belden 9451
   2. Line Level Audio: (AL) Belden 9451
   3. Speaker Cable: (SL, SH, SZ) West Penn C210 (main speakers), West Penn 227 (monitor speakers), West Penn 225 (70.7 V Systems)
   4. Control: (CG, CR) Belden 9455 (9 conductor control cable) Low Voltage AC power sequencing, (CS, CI) Belden 9451 Serial control cable.

D. Conduit: All cable and wire shall be run through EMT conduit. Separate conduits shall be used for video, line-level and microphone level audio, control, amplified audio to speakers, and network signals.

E. AC Power Sequencing and Distribution: Each equipment rack shall have power sequencing to supply power to each component in a sequenced manner. A power-on switch shall be provided at each rack. All AV equipment shall be supplied with transformer isolated AC power.

F. All equipment and components shall be new and complete. No used or reconditioned equipment shall be acceptable.

G. All mounting hardware shall be included.

H. All equipment and components shall be factory tested prior to shipping.

I. All bolts and fasteners must be Grade 5 or better.

J. All bolted attachments to have lock washers or other approved self-locking hardware.

K. All microprocessor controls shall utilize a non-volatile memory. System configuration, operating parameters, presets, etc. shall be protected against system power failure for a minimum of 48 hours.

L. All internal rack wiring shall be factory completed and clearly marked. All field connections shall be by connector, terminal strip or other device previously specified. Any terminal strip connections shall be clearly labeled as to terminal designation.

M. All wire sizes and insulation to comply with UL standards and local codes.

N. All wiring to be harnessed and bound. No loose or randomly routed wires shall be permitted.

O. No manufacturer logo shall appear on control station face plates or any other device located in public areas.

P. Any supplementary or auxiliary equipment necessary for the operation of the system shall be supplied with overload and short-circuit protection.
Q. Do not purchase or fabricate any materials, components or items to be used in the sound, video and communication systems prior to review of shop drawings, unless otherwise directed by AV Consultant.

R. Use only materials, components and items that conform with industry practice and applicable code standards. Use only components which are new and never previously used. Take care during installation to prevent scratches, dents, chips, etc.

S. Install all rack-mounted equipment with 10-32 button head machine screws with Phillips head.

T. Custom rack panels shall be 3/16" thick aluminum, standard EIA sizes, brushed black anodized finish unless otherwise noted. (Brush in direction of aluminum grain only.) Custom connector plates (loudspeaker, microphone, video, etc.) are typically stainless steel. It is the responsibility of the Contractor to verify plate finish with the AV Consultant. Plastic plates will not be accepted.

U. All engraving shall be 1/8" block unless noted otherwise. Except where noted to the contrary, on dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum plates, or light-colored pushbuttons, letters shall be black.

V. Connections shall be made with approved connectors and/or terminal blocks equal to Cinch 140 series or as indicated. Mount trim potentiometers, custom circuit cards, relays and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved lamacoid labels.

W. Per IEC-268 standard, all XLR connectors, within equipment or out, shall be wired pin 2 hot (high), pin 3 low, and pin 1 shield (screen).

X. Unless otherwise stated, all rack-mounted electronic and electrical equipment and components shall conform to EIA 19" standard. Any devices not specifically designed to be rack mountable shall be adapted, by professionally acceptable methods, to meet the EIA standard.

Y. The rack height of all equipment and components in this specification is in 1.75" (44mm) units denoted xU", i.e., a 5.25" device, which is three rack spaces high is denoted as "3U".

Z. All components shall be factory tested prior to shipping.

AA. All switches used in these systems (whether or not mentioned or shown in this specification) shall have sufficient voltage and amperage rating to cover the use for which they are required with a safety factor of at least 2. All switches handling audio circuits shall use gold contacts and shall meet JAN-S-23 or MIS-S-3950A specifications or equivalent. Used LED lighted switch to indicate on, off and preset conditions.

BB. Audio transformers shall be of appropriate impedance ratio and power handling capacity for the function intended and, unless otherwise noted herein, shall have a frequency response within +/-1 dB from 20-20,000 Hz.

CC. All joints and connections shall be made with rosin-core solder or with mechanical connectors approved by the AV Consultant. Where spade lugs or other crimp-type terminals are used,
crimp properly with ratchet type tool. Between racks, cabinets, consoles or modules, all cable shall terminate in approved terminal connectors, strips, blocks or boards.

DD. Route unbroken microphone audio line and control wiring from receptacle plate/chassis to rack. Remove spliced cables and replace without additional charge to Owner.

EE. No splices shall exist in any length of wire run except where noted on drawings.

FF. Connect all loudspeakers electrically in phase, using the same wire color code for loudspeaker wiring throughout the project.

GG. All wiring and connections shall be completely visible and labeled in rack. Termination resistors shall be 1/2 watt metal film 1 % tolerance; fully visible and not concealed within equipment or connectors.

HH. All terminations of shielded cables shall consist of a PVC or neoprene heat shrink sleeve covering the shield drain wire and an overall PVC or neoprene heat shrink sleeve covering the point at which the cable jacket and shield end.

II. Run vertical wiring inside rack in properly sized raceway with snap-on covers (Panduit type E series). Horizontal wiring in rack to be neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars for cable bundle sag. Neatly bundle excess AC power cable from rack-mounted equipment with plastic cable ties. Rack wiring to be bundled with plastic cable ties or lacing twine. Electrical tape and adhesive-backed cable tie anchors are not acceptable.

JJ. Audio Shielding /Grounding:

1. All shielded cables shall have their shields isolated from both the conduit system and any other shielded cables. Shields shall be continuous from source to input points. Shields shall be connected at input points only, with shields lifted at the source, except as noted below.

2. Microphone wiring shall have continuous shields from the microphone receptacle to microphone patch jack and if normalled to a console microphone input, continuous to that point.

3. Tie-line patch points shall have continuous shield connection from one patch jack to another with no permanent connection to the audio ground network.

4. Unbalanced wiring, such as used in certain communication systems, shall have audio shields connected at device inputs and floated at device outputs. Strap shield to "low" side of unbalanced input.

5. No "doubling up" of ground points on multi-pin connectors or terminal blocks shall be allowed.

6. Shielded audio cables that normal through patch panels shall utilize a normalling type jack which has an isolated switching "break" circuit. This shall be used for sleeve normalling.

KK. AC Power and Grounding:
INTEGRATED AUDIO VISUAL SYSTEMS

1. Coordinate final connection of power and ground wiring to racks. Hardwire power wiring directly to power contactors or internal AC receptacles to ensure uninterrupted power.

2. Install approved isolated-ground receptacles in wireway in each rack. Provide a minimum of two spare outlets in each rack. Label each outlet as to which AC circuit is feeding it and provide the same information in the circuit breaker panel.

3. Install a copper ground buss bar top to bottom in each rack, insulated from the rack. Ground equipment chassis not having a three-wire power cord to these busses. Connect green ground wire from each AC outlet in rack to this bus bar.

4. AC power for the AV Systems is distributed at 120VAC, 60Hz, on the same electrical phase, building wide.

5. Isolated-Ground (Audio Ground) Distribution:
   a. The sound system "isolated ground", including ground source, ground conductors, and ground distribution points shall be installed by the Electrical Contractor. The isolation and ground continuity of this network, although the responsibility of the Electrical Contractor, shall be reconfirmed by the AV Contractor prior to installation of equipment.
   b. Except at the ground source, the audio ground shall be totally isolated from all other electrical grounds. Therefore, if the connection between the audio ground network and the ground source is disconnected, no continuity between the audio ground and the building electrical ground shall exist.
   c. All equipment racks containing active electronics shall be connected to the audio ground, except as otherwise noted in this specification. Caution must be exercised so that these racks are not permanently, or in any way during operation, capable of being accidentally connected to the building safety ground.
   d. All conduits and back boxes containing AVC Systems wiring shall be permanently connected to the building electrical safety ground.
   e. Note: RF video devices, being unbalanced in nature, shall not be connected to the sound system audio ground network. Care shall be taken when intermixing such video and audio equipment.

LL. Electrical Safety:

1. No voltage in excess of 25V RMS AC or 24V ripple free DC shall be exposed to touch in normal use or in any equipment by the withdrawal of modules or of any plug or connector or without the removal of suitably indelibly labeled covers.

2. Unless specifically excepted, all live electrical parts above 50V RMS AC or 60V ripple free DC, including terminals, shall remain completely shrouded by insulation or grounded metal when the main access panels are removed. The separate shrouds or covers shall require a tool to remove them to prevent inadvertent contact with live parts.

3. In addition, where enclosures or items of equipment containing predominantly control, computer, or similar low voltage signals also contain voltages in excess of 50V RMS AC or 60V ripple free DC, clear standard warning notices indicating the maximum voltage present shall be provided on all removable access panels. Similar warning notices shall be provided where voltages exceeding 120V are present in any enclosure or item of equipment and such a voltage would not reasonably be expected to be present.
4. Within enclosures, racks and panels identify with prominent, standard, and indelible signage which circuit breakers or disconnects are to be switched off in order to isolate the equipment totally. Warning notices shall also be provided on all equipment which contains live terminals after operation of its circuit breaker or disconnect. These terminals must be completely shrouded to prevent inadvertent contact.

5. All equipment, control stations, equipment racks, enclosures, and all metal cases, raceways, and conduit shall be efficiently grounded. Special hand held or portable equipment which is not double insulated shall have duplicated grounding connections. All grounding shall be in accordance with the current edition of the National Electrical Code and as identified within this specification.

MM. Noise From Equipment

1. The residual noise and hum output of the systems shall be such that PNC-15 or below can be measured at the center of main floor, and the character of the remaining noise must be random, with no audible discrete frequency components.

2. Where a control panel or rack is to be used or located in an operational area, such as on the fly chamber, gallery, or control room, there shall be no acoustic noise associated with the panel. No internal cooling fans or similar moving or magnetic equipment shall be permitted unless approved by the AV Consultant in writing.

3. Operation of switches, pushbuttons, relays, solenoids, and similar shall not be audible to members of the audience.

2.3 LOUDSPEAKER ARRAYS – GENERAL REQUIREMENTS

A. Design and provide all required mounting brackets, hardware and components, safety systems and rigging systems using a minimum safety factor of 7:1.

B. Provide all integral redundancy components, such as safety cables, as required to meet these criteria.

C. Coordinate cluster weights and hang locations with Structural Engineer to ensure sufficient structural support.

2.4 EQUIPMENT RACKS AND ENCLOSURES

A. EIA 19" standard racks providing up to 44 rack units or as directed on the associated drawings of panel space (overall height: 83"), 24.25" of width, and 22" of depth, minimum. This rack is supplied with rear door and adjustable front and rear mounting rails.

B. Provide interior switched incandescent work lamp for each rack.

C. Provide matching blank panels in all spare rack spaces. See "blank panels" section.

D. Provide matching 1 U ventilation panels above and below all power amplifiers, and additional vent panels as shown in rack elevation drawings.

E. Provide one (1) rack mount AC power receptacle strip for each rack group, with a minimum of one (1) 120V 20A duplex receptacle (NEMA 5-20R) for each individual rack (e.g., a group of
three (3) racks requires a total of three (3) duplex receptacles. Receptacle strip shall mount to the front of one rack and be connected to an unswitched AC power circuit.

F. Provide heavy copper busbar in each rack for connection of isolated ground circuits. Bond busbars together with 3/0 A WG welding cable in a "star" configuration. Refer to AC power grounding detail on EE drawings for further information.

G. All racks shall have the same color finish (Textured Black).

H. All metal cabinets connected to the sound system audio ground shall be effectively isolated from any conduit or other metallic component that is connected to the building electrical safety ground.

2.5 AV RECEPTACLE PANELS AND NEMA WALL BOXES

A. Custom Fabrication: Single or multiple signal level and circuit receptacle panels shall be provided for connection of auditorium devices at designated locations in the facility. Panels may include any combination of circuits and connectors for these signal levels: microphone level, line level, video level, intercom level, and low volt/impedance loudspeaker level. Connectors shall be identified as to signal level, circuit type, and circuit number by clearly engraved and coordinated legends on each panel. Exceptions as noted. Refer to device plans for locations.

B. Refer to Systems Panel & Device Schedule (Electrical Drawings) for back box type, size, and depth, and mounting information. Special care must be taken in several areas due to shallow wall depths.

C. Conduit and AV system back boxes shall be supplied and installed by others.

D. AV system panel covers shall be provided and installed by the AV Contractor, except as noted.

E. Wire shall be supplied, pulled, and terminated by the AV Contractor.

F. Connector: Panel or chassis types, as indicated below. Mount on AV system panel as shown on drawings and fasten with stainless steel machine screws, hex nuts, and lock washers (screw head style, color, and thread size to match connector body; slot or Phillips drive to match wall plate screws). Refer to connector specification paragraph below. Exceptions as noted.
   - Microphone level ("AM" series): Female XLR-3.

G. Engraved Legend: Details as indicated below. Locate legends on AV system panel as shown on drawings. Characters shall be engraved, filled with colored enamel, and entire panel sealed. Exceptions as noted.

H. Legends shown on drawings are typical. Refer to AV systems block diagrams and/or submit proposed layout to AV Consultant for review.

I. Signal level title legend size shall be 0.1875" or 0.250" high characters of medium weight (as required).
INTEGRATED AUDIO VISUAL SYSTEMS

J. Termination:
   1. XLR-type Connectors: Solder wire directly to connector in the field.
   2. Neutrik NL4 Series Connectors: Attach properly sized crimp-type female disconnect terminals to large gauge loudspeaker wire and mate with male disconnect terminals on the Neutrik connectors. Securely strain relief loudspeaker wires to connector body or wall plate to ensure integrity of the electrical/mechanical disconnect termination.

K. Wall Receptacle Plates (Sizes As Shown On Drawings And Schedules):
   1. All plates shall be flush type for mounting to recess back boxes or surface mount Wiremold-type boxes.
   2. Wall Plate: Standard, x-gang (size "x" to match detail drawings), type 302 stainless steel (heavy gauge), bright brushed or satin finish, flush-type electrical wall plate. Mount to back box with 6-32 stainless steel, slot or Phillips drive, oval head machine screws.
   3. Plates in public areas to have finish by Architect.
   4. AV Panels (Sizes As Shown On Drawings And Schedules): Fabricated of type 5052-H32 aluminum, 0.125" minimum thickness, lightly brushed (vertical direction), with black anodized and clear sealed finish. Panel dimensions to match back box size. Edges of panel shall be ground square and flat. Corners of panel to have small radius. Exceptions as noted below.

L. Audio Connectors
   1. XLR-3 (Microphone, Line; Communication): Neutrik NC3MD-L-l (male) and NC3FD-L-l (female) panel mount connectors; Neutrik NC3MX (male) and NC3FX (female) cable connectors. Silver contacts and nickel shells throughout. Balanced mic/line: pin 1 shield, pin 2 hot, pin 3 low. Unbalanced mic/line: pin 1 shield, pin 2 hot, pin 3 tie to pin 1. Production Intercom: pin 1 shield, pin 2: +30VDC, pin 3 audio/signal.
   2. In no case shall pin 1 be tied to case of connector.
   3. XLR-4 (Production Intercom Headset/Handset): Neutrik NC4MC (male) and NC4FC (female) cable connectors. Silver contacts and nickel shells throughout.
   4. NL4 Type (Loudspeaker): Neutrik Speakon NL4MP panel mount connector; NL4MPR sealed loudspeaker cabinet chassis connector; and NL4FC cable connector.
PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate work with other trades to avoid causing delays in construction schedule.

B. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place, with equipment supports having safety factor of 7 for speaker mounts and 3 for all other equipment.

C. Cover edges of cable pass-through holes in chassis, racks, boxes, etc, with rubber grommets or Brady GRNY nylon grommet material.

D. Speakers mounted in acoustical tile ceilings must be properly supported with tile bridges or similar structural bracing.

E. System Wiring: Take precautions to prevent and guard against electromagnetic and electrostatic interference (hum and buzz). Check AC power and grounding prior to AV system installation, and report any issues promptly.

F. Equipment and Cable Labeling: Provide engraved lamicoid labels on front and rear of active equipment mounted in racks. Include name of device, reference to drawing name, and other areas the device feeds or controls. Label cables in a consistent manner, with permanent, heat-shrunk labels. Show all equipment designations in Permanent Record Drawings.

3.2 INITIAL TESTS AND ADJUSTMENTS

A. Preliminary: Verify the following before beginning actual tests and adjustments on the system:
   1. All electronic devices are properly grounded.
   2. All powered devices have AC power from the proper circuit. Verify all dedicated AC power circuits are properly wired, phased, and grounded.
   3. Insulation and shrink tubing are present where required.
   4. Dust, debris, solder splatter, etc. is removed.
   5. All cable is dressed, routed, and labeled; all connections are properly made and consistent with regard to polarity.

B. Grounding System Tests:
   1. Measure the DC resistance between the technical ground in any equipment rack or console and the main building ground. Resistance should be 0.15 ohms or less.
   2. Temporarily lift the technical ground from the main electrical ground, and measure the DC resistance between them. Resistance should be at least 1 Megohm.
   3. Verify the electrical contractor has connected the technical ground to building ground at only one location with 1/0 or larger wire.
   4. Measure the DC resistance between the signal ground at any interface plate and the conduit system.
   5. Identify and correct any problems if within the Audio system scope of work; notify the General Integrator if problem is in a related area of work.
C. Audio System Tests: Perform the following tests and adjustments, supplying all test equipment required. Follow EIA Standards RS160 and RS219 in performing tests. Make all corrections necessary to bring system(s) into compliance with the specifications. Design goals for the system have been calculated in accordance with accepted industry standards. Actual performance may deviate slightly due to component variations, field conditions or limitations, and building interaction. Design parameters are: system frequency response shall be +/- 3dB 50 Hz -16 kHz. Evenness of coverage shall be +/- 3dB maximum at 2 kHz throughout listening area. Nominal sound pressure level shall be 95 dBA SPL at any seat in the auditorium area with a maximum continuous SPL capability of 105 dBA.

1. Measure and record the impedance of each speaker line circuit terminating at the equipment rack, with speakers connected, employing frequencies of 125, 500, 1000 Hz, and 4000 Hz and others as appropriate to the driver (use all for full range systems).

2. Adjust the gain of each active device to provide optimum signal-to-noise ratio and 18 to 20 dB headroom. Record input and output levels at each step in the signal chain.

3. Measure and record overall system hum and noise level of each mic or line amplifier with controls set so that -50 dBu microphone input or +4 dBu line level input would drive the system to full amplifier output. Terminate inputs with appropriately sized shielded resistors (150 ohms typ) for this test.

4. Measure and record electrical distortion of each input through amplifiers, switching, and power amplifier for each system installed; distortion should be less than 0.5% for the overall system in each test. Observe the output waveform on an oscilloscope for freedom from clipping, parasitics, oscillation, or RF components which could indicate unacceptable system operation.

5. Measure and record system electrical frequency response for each input channel through power amplifier output. Deviation shall not exceed +1 dB within the range 30 to 18,000 Hz.

6. Check system to assure freedom from oscillation or stray RF pickup. Check all inputs without signal and with 1000 Hz sinewave driving system to full output. Detect unwanted signals on oscilloscope at rack termination and over single loudspeakers connected at the farthest distance from the rack for each loudspeaker line.

7. Measure and record the output impedance of each active device operating as a source to a passive device or network. Measure and record the input impedance of each active device used to terminate passive devices.

8. Check polarity of all loudspeakers with an electronic polarity checker and by applying music program or pink noise signal to system while walking through the transition areas of coverage from one loudspeaker to the next. Transition should be smooth with no apparent shift in source from one speaker to the next.

9. Apply sinewave sweep signal to each loudspeaker system, sweeping from 50 to 5000 Hz at a level 10 dB below full amplifier output, and listen for rattles or objectionable noise.

10. Verify system frequency response, coverage to all seating areas, and phase response using a TEF or Smaart system.

D. Report: Upon completion of initial tests and adjustments, submit written report of tests to Owner along with all documents, diagrams, and record drawings required herein. Report shall include date of each test, pertinent conditions such as control settings, etc., test circuit, and test
equipment employed. In addition, submit written notification that the installation has been completed in accordance with the requirements of the Contract Documents, and is ready for acceptance testing.

3.3 TEST EQUIPMENT

A. Provide the following test equipment on site and available to the Owner during acceptance testing. Provide and use only new test tapes for this project.

1. Tools including screwdrivers, pliers, cutters, wire strippers, nut drivers, crimpers, heat shrink blower, controlled temperature soldering unit, ladders, flashlight, measuring tape, electric drill, etc.
2. Goldline TEF or Smaart system calibrated within one year of the testing.
3. Sine Wave Generator. Output: +4 dBu, 5 Hz to 50,000 Hz with less than 0.05% THD into any load. Acceptable: Audio Precision, Hewlett Packard, Sound Technology, or Tektronix.
4. Pink Noise Source. Equal energy per octave bandwidth 20 - 20,000 Hz, +1 dB (long-term average) @ 0 dBu output. Stability: +2 dB per day. Acceptable: Ivie IE-20.
5. Impedance Meter. Capable of testing audio lines at three frequencies, minimum, between 250 Hz and 4000 Hz. Measurement Range: 1 ohm to 100,000 ohms. Acceptable: Sennheiser ZP-3.
6. Multimeter. Measurement range, DC to 20,000 Hz, 100 mV to 300 V, 10 ma to 10A. Acceptable: Fluke 77.
9. Sound Level meter meeting ANSI SL.4 1971 Type 2. Acceptable: GenRad 1933 or B&K.
10. Dual-trace oscilloscope: 100 MHz bandwidth, 1 mV/cm sensitivity. Acceptable: Tektronix 2445.

B. Turn over Test CDs and Audio Cassette(s) to Owner for maintenance upon completion of Acceptance Testing.

3.4 ACCEPTANCE

A. Acceptance testing will include operation of each major system and any other components deemed necessary. AV Contractor will assist in this testing and provide the test equipment specified herein. AV Contractor shall provide at least one technician available for the entire adjustment and testing period (day and night), to assist in tests, adjustments, and final modifications. All tools and material required to make any necessary repairs, corrections, or adjustments shall be furnished by the AV Contractor.

B. The Owner will physically inspect the system to ensure all equipment is installed in a neat and professional manner and as required by the contract documents. An inventory will be made of all equipment.
C. The following procedures will be performed on the System:
   1. Adjust, balance, and align all equipment for optimum performance and to meet all manufacturers’ published specifications. Settings to be reviewed include gain, delay times, and nominal settings. Establish and mark normal settings for all level controls, and record these settings in the System Reference Manual.
   2. Check all control functions for proper operation, from all controlling devices to all controlled devices.
   3. The audio fidelity test will consist of driving the speaker system with pink noise and measuring the response in each 1/3 octave band from 50 to 16,000 Hz. Equalization as specified shall be used to adjust the response as necessary to fit the requirements of the space.
   4. Any other test on any piece of equipment or system the Owner deems appropriate.

D. In the event the need for further adjustment or work becomes evident during acceptance testing, the AV Contractor will continue his work until the system is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications, the AV Contractor will pay for additional time and expenses of the AV Consultant at the AV Consultant’s standard rate in effect at that time, during any extension of the acceptance testing period.

3.5 INSTRUCTION OF OWNER PERSONNEL

A. Provide 12 hours of instruction to the Owner’s designated personnel on the use and operation of each of the systems. The instructor must be fully knowledgeable of all system functions and all equipment features. The System Reference Manuals shall be complete and on-site at the time of instruction. The AV Contractor shall be present at the first two formal uses of the system.
INTEGRATED AUDIO VISUAL SYSTEMS

ATTACHMENT A: EQUIPMENT LIST [TBD]

End of Section
PART 1 - GENERAL

1.1 WORK INCLUDED
A. Furnish and install all labor and materials required for the installation of cabling that will support an OFOI cable TV distribution system. This work is to provide a “pull only” and termination of the station outlets for the system.
B. Owner will provide all amplifiers, splitters, taps, and IDF closet terminations. Others will provide televisions, video sources (VCR/DVD/etc), and all in-room drop cords. Close coordination with the owner will be required.

1.2 RELEVANT SECTIONS
A. 270528 Telecommunications pathways
B. 271313 Telephone Backbone Cabling
C. 271323 Optical Fiber Backbone Cabling
D. 271513 Augmented Category 6 Horizontal Cabling

1.3 QUALITY ASSURANCE
A. Do all work in accordance with the guidelines published in EIA/TIA standard 568 and 569. Where conflicts exist, the plans and specifications shall take precedence. All manufacturer installation instructions shall be followed.
B. All workers involved in the installation and termination of cable shall have at least one year of experience. No less than 33% of the workmen on the job shall have attended a vendor sponsored training program covering installation of cable TV systems.

1.4 SUBMITTALS
A. Submit five sets of product data. Submittals will be required for the following items.
   1. Cut sheets for all products used.

1.5 GUARANTEE
A. Guarantee all work against faulty and improper material and workmanship for a minimum period of one (1) year from the date of final written acceptance by Owner, except where guarantee or warranties for longer terms are specified herein.
B. Upon notification of a problem, the warranty provider shall furnish within 48 hours and at no cost to the owner, such labor and materials as are needed to restore the system to proper operation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Amplifiers: by owner
B. RG6 drop cable: quad-shield Commscope, Belden
C. Cable TV Backbone Cable: Commscope PIII-500
D. Splitters/taps: by owner.
E. F-connectors: any manufacturer compression type F connectors similar to Thomas and Betts snap-n-seal product
F. Station device plates: Panduit device plates with mini-com CMFSRIxx self terminating F connector.

2.2 CABLE TV DISTRIBUTION
CABLE TELEVISION CABLING

A. All cable TV drop cable shall be CATV/CL2 or CATVP/CL2P rated quad-shield RG6.

B. Cable TV backbone cable shall be run from the service entrance room location to each of the telecommunication rooms. Cable TV backbone cable shall be of .625" rigid construction.

C. The actual cable TV distribution system itself will be provided by others. This work is to install horizontal and backbone cabling and station termination of horizontal cable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall furnish and install all cabling in accordance with these specifications, and as indicated on the cable schedules and drawings.

B. Install each cable TV drop as an uninterrupted conductor section between the IDF location and the station outlet. There shall be no splices or mechanical coupler installed between the cable points of origin and termination except as shown on drawings and or specifications. Daisy chaining of station outlets is not acceptable.

C. At the IDF location, all cable TV RG6 drop cabling shall be installed to an owner-specified area of the communications backboards, identified, and coiled for finish work by others.

D. The station end of the drop cable must be terminated with a compression F connector and installed into a self terminating F connector bulkhead mounted in a communications device plate.

E. There are locations where the station end device plate will be shared with the existing augmented category 5e cabling. Coordination with the 271513 sub-contractor will be required to coordinate the provisioning of communications device plates. It is in the scope of this work to coordinate the device plate and cable installation in these shared locations.

F. Backbone cable TV cabling shall be installed as shown on the drawings. This cable shall be identified and coiled on the owner-specified area of the communications backboards.

G. Cable pulling shall be coordinated with other limited energy cabling installation contractors to eliminate any possibility of damaged cabling.

H. The cable TV cabling in the IDF shall be installed with sufficient and appropriate mounting clips, brackets, and cable management to provide a neat, secure, and maintainable system.

I. Contractor is responsible for insuring that cable jacket is suitable for the environment in which it is placed (i.e., CATV/CL2, CATVP/CL2P rated).

J. All cable shall be routed through the building cable tray/conduit system, where available.

K. Where cable tray or conduit is not available, cable bundled neatly and shall be attached to building structure at intervals not to exceed 5 feet.

L. At the same time cable is pulled into a cable pathway, also install a pull string of appropriate size to facilitate future cable pulls along those pathways.

M. The contractor will be responsible for the installation of all "J-hooks" for horizontal cable support. Coordinate location of support hardware to avoid conflicts with other trades.

N. At no point will any station cable be tie wrapped or fastened to the cable tray. After cables have exited the cable tray they will be tie wrapped to the "J-hooks". The tie wraps will be cinched snug enough around the cable bundle to keep them uniform and in the hooks, but not so tight as to damage the construction of the cables themselves.

O. Provide fire stopping at all locations where cables penetrate fire rated surfaces. Materials and methods used shall be acceptable to the code authority having jurisdiction and shall maintain the fire integrity of the wall, floor, or ceiling.
P. Contractor shall closely coordinate and work with the owner and engineer on the construction, termination and routing of the cabling in the IDFs, overhead ladder racking, and backboard space allocation.

3.2 IDENTIFICATION

A. Cable tags containing a unique cable ID designator shall be placed on both ends of all cables, 6 inches from the connector. Each label shall be typewritten with permanent ink with the appropriate cable number as indicated. Hand written cable labels are not acceptable.

B. Individual cable sheaths and station end faceplates shall be labeled with the designator of the specific cable. Cable designation shall consist of the IDF letter designation and the individual cable number. Cable sheaths shall be labeled on each end. Station device plates shall be permanently labeled in typewritten ink with the letter of the IDF the cable is run followed by the 3 digit cable number. Cables shall be numbered sequentially, starting from 1. Each IDF termination shall be labeled with cable number and permanent (not construction) room designation.

3.3 TERMINATION HARDWARE

A. All terminations of cable TV RG6 shall be via compression F connectors.

3.4 SYSTEM TESTING

A. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.

B. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable, except by prior written approval from the Architect.

C. Remove all defective cables from pathways system. Do not abandon cables in place.

D. Testing shall involve continuity testing to verify that the installed cabling has not be cut or shorted during the installation process.

E. The owner further reserves the right to conduct, using Contractor equipment and labor, a random re-test of up to five percent (5%) of the cable plant to confirm documented test results.

F. All test results and corrective procedures are to be documented and submitted to the Owner within fourteen (14) working days of test completion.

3.5 ACCEPTANCE

A. Upon receipt of the Contractor's documentation of cable testing, the Architect will review the installation and may request a test in his presence, of up to 1% of the cable drops installed.

B. The contractor shall provide the owner with hands-on training for the use and operation of the system.

3.6 AS-BUILT DOCUMENTATION

A. The contractor shall provide CAD prints and disks of the electrical set of prints indicating final faceplate location, faceplate designations, as well as major conduit, cable tray, and installed cable routes.

B. The contractor shall provide CAD prints of the one-line diagram of the system showing signal levels at every device, including every outlet in the system.

C. The contractor shall provide 3 copies of all test results neatly bound and organized. Each test shall clearly indicate cable designations.
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. The purpose of this Section is to define the scope of work upon which the security contractor, hereafter known as Contractor, is to base his bid, to establish the design and installation criteria to be used, and to define design submittals which will be required in the preparation and execution of the design.

1.2 SCOPE

A. Contractor Performance Requirements

1. Contractor shall provide and installed a fully operational access control system and video surveillance system in accordance with University of Oregon Campus Construction Standard section 280000. Contractor shall provide all required documentation to include, but not limited to: material submittals, shop drawings, testing results and final as-built drawings of all security systems.

2. The Contractor is responsible for design and preparation of shop drawings and shall identify all such work in the process of design and preparation of construction documents.

B. Related Sections include the following:

1. 28 0000 Electronic Safety & Security (UO Campus Construction Standards)
2. 28 1000 Electronic Access Control & Intrusion Detection (UO Campus Construction Standards)
3. 28 2000 Electronic Surveillance (UO Campus Construction Standards)
4. 283000 Electronic Detection & Alarm (UO Campus Construction Standards)

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

   a. Trained and certified by manufacturer in security system design.

2. System Operation Description: Detailed description for this Project.

END OF SECTION
PART 1 - GENERAL
1.1 WORK INCLUDED
A. The ACS system installed under this scope of work shall provide controlled access to building interior and real-time monitoring of doors at multiple locations simultaneously.
B. The ACS system shall be controlled by FS Lock & Door Shop existing computer system. ACS system hardware installed under this scope must be compatible with current version and allows future upgrades.
C. The ACS building controllers shall be LAN addressable and shall be connected to FS Lock & Door Shop provided Ethernet receptacles.
D. At reader doors where power assist devices are located, the ACS system shall shunt the exterior power assist operator button while door is locked so that it may only be used with valid card presentation to protect power assist drive assembly.
E. The ACS system shall control primary access points to be determined with each project and requires FS Lock & Door Shop review and approval.
F. All doors controlled by ACS shall be equipped with request-to-exit (REX) devices and door contracts.

1.2 SUBMITTALS:
A. Manufacturer's specifications and technical data for all components.
B. List of programming decisions that need to be made by the FS Lock & Door Shop for proper operation of the system. Included in this list shall be all console/local passwords or access codes as well as any proposed field-assigned passwords or access codes.
C. Panel and power supply drawings layouts on backboard allocated for CCTV and ACS in telecommunications closet. Indicate desired location of 120 VAC power receptacles on this drawing for coordination.
D. One-line diagram showing all devices, controllers, and cable types between devices.

1.3 QUALITY ASSURANCE:
A. All workers involved with this installation must have completed manufacturer training and have a minimum of 2 years experience installing like equipment or have a minimum of 5 years of installation experience with specified equipment.

PART 2 - PRODUCTS:

<table>
<thead>
<tr>
<th>Access Control Product</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Note(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building ACS Controllers</td>
<td>AMAG</td>
<td>Multi-Node 2100 series</td>
<td>Required to integrate into existing campus access control system.</td>
</tr>
<tr>
<td>Proximity Readers</td>
<td>Indala</td>
<td>FlexPass mid-range FF3213A+ / 10022</td>
<td>To be 26 Bit Wiegand compliant for card only entry. Or with optional</td>
</tr>
<tr>
<td>ACS Rex Device</td>
<td>Bosch</td>
<td>To be approved</td>
<td></td>
</tr>
<tr>
<td>ACS Door Contact</td>
<td>Sentrol</td>
<td>To be approved</td>
<td></td>
</tr>
<tr>
<td>ACS Door Prop Alarm</td>
<td>Design Security, Inc.</td>
<td>To be approved</td>
<td>With key switch.</td>
</tr>
<tr>
<td>Electrified Locking Device</td>
<td>VonDuprin</td>
<td>6000 series; 24VDC strike plates</td>
<td></td>
</tr>
</tbody>
</table>
### ELECTRONIC ACCESS CONTROL & INTRUSION DETECTION

<table>
<thead>
<tr>
<th></th>
<th>HES</th>
<th>9600 series; 24VDC surface mounted rim device</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Door Lock Device</td>
<td>-</td>
<td>-</td>
<td>Allowed ONLY with prior FS Lock &amp; Door Shop review and approval.</td>
</tr>
<tr>
<td>Wire &amp; Cable</td>
<td>-</td>
<td>CAT 5</td>
<td>UL listed for use in plenum spaces. Installed per manufacturer’s instructions.</td>
</tr>
<tr>
<td>Outdoor Wire &amp; Cable</td>
<td>-</td>
<td>CAT 5</td>
<td>UL listed for outdoor use; wet environments; recommended for such use by manufacturer. Installed per manufacturer’s instructions.</td>
</tr>
<tr>
<td>Door Release Button</td>
<td>-</td>
<td>-</td>
<td>Momentary switch as approved by FS Lock &amp; Door Shop. Located at DVR or monitor.</td>
</tr>
<tr>
<td>Post Base for Card Reader</td>
<td>-</td>
<td>-</td>
<td>OFCI; Division 08</td>
</tr>
</tbody>
</table>

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

A. Install all equipment and cabling in a manner consistent with manufacturer recommendations and instructions.

B. Install all devices and components shown on drawings required for proper operation of the system.

C. Mount devices level and in a uniform fashion.

D. Install FS Lock & Door Shop furnished post bases for card readers in coordination with concrete pours.

E. Also coordinate installation and pours with required power.

F. Contractor shall furnish and install all cabling associated with the operation of both CCTV and ACS system.

G. Contractor shall not pull any ACS cables in conduits containing or intended to contain voice and data wiring.

#### 3.2 EQUIPMENT & SYSTEMS:

A. Coordinate with FS Lock & Door Shop setup of Ethernet network and IP address assignment; setup programming for ACS building controllers; reader definitions; door alarm points.

B. When the installation of all system components and cabling is complete, initial testing shall consist of local walk-through, and working demonstration of all features.

C. All passwords or access codes for the system shall remain at factory default unless the factory default poses a security risk, in which case all passwords shall be communicated in writing and give written FS Lock & Door Shop approval of such change. Any costs associated with password recovery shall be borne by the Contractor.

D. The Owner shall be provided with a minimum of 2hrs training of the installed system after all startup and testing procedures have been completed and as-built documentation delivered.

1. Minimum hours of required training may increase based upon the system size and complexity.

2. Training will include both an overview for building occupants and an in-depth session for FS maintenance to a service level.
ELECTRONIC ACCESS CONTROL & INTRUSION DETECTION

F. Prior to FS Lock & Door Shop final acceptance of the system all zones must be tested in the presence of designated representative(s) from FS Lock & Door Shop.

3.3 CLOSEOUT, WARRANTY, AND SUPPORT:

A. With as-builts, record drawings, O&M manuals, etc. deliverables a complete list is required of all system devices, power packs, etc. noting their installed locations.

B. Guarantee all work against faulty and improper material and workmanship for a minimum of 1 year from the date of final written acceptance by FS Lock & Door Shop, except where guarantee or warranties for longer terms are clearly requested and specified.

C. During the entire warranty period the Contractor must provide all related software upgrades to the installed system(s).

D. Upon notification of a problem, the warranty provider shall furnish within 48 hours at no cost to the Owner such labor and materials as are needed to restore the system to proper operation.

E. During the entire warranty period the Contractor must guarantee a 4 hour response time for problem resolution.

F. Prior to the end of the warranty period, with FS Lock & Door Shop present, the Contractor is to conduct a 1 year inspection repairing any item(s) at Contractor’s cost and provide a report of system equipment and system operational functions.

END OF SECTION
PART 1 GENERAL

1.01 SURVEILLANCE AND INTRUSION SYSTEMS

A. All labor, equipment, materials, documentation and services necessary for a complete and operational Closed Circuit TV (CCTV) monitoring system. Work will include the installation of wiring, cabling, cameras, power supplies, digital video controllers, flat panel displays, and other components necessary to provide a fully operational CCTV monitoring.

B. Installed system shall be a turnkey package including design review, construction supervision, coordination, and commissioning services.

C. OFOI and/or OFCI hardware will be determined by each project with the FS Lock & Door Shop.

D. The system wiring, equipment, and installation shall comply with all listed requirements as well as any and all applicable national, state and local codes and standards.

E. System Description:

1. The CCTV monitoring system installed shall provide for real-time monitoring of multiple cameras at multiple viewing locations simultaneously, as well as, recording for later review of video.

2. The CCTV system shall be equipped with a video recorder (DVR or NVR where applicable NVR equipment is specified) that shall have the following characteristics:

   a. Equipped with a 16 port PoE (Power over Ethernet) switch or 16 camera ports.
   b. Equipped to serve remote display of live and recorded video over client LAN. Client software shall be provided with DVR / NVR.
   c. Record at a minimum of 12 frames per second with DVR system and 5-7 frames per second with NVR system for each camera location simultaneously.
   d. Feature that it records only when motion is detected. Motion is defined to be changes in pixels on a camera allowing the user to specify the percent pixel change that defines motion.
   e. DVR / NVR shall be a 16 camera unit with 500 GB storage capacity.
   f. Stored video shall be retrievable from the DVR / NVR indexed by time and have fast-forward and rewind functions.
   g. DVR shall be equipped with a keyboard, mouse, and 17" color LCD display.
   h. DVR / NVR shall allow live monitoring and continuous recording while viewing stored video.

3. Cameras shall:

   a. Be 1/3 inch color cameras having minimum of 480 TV lines of resolution. IP cameras capable of low-light recording (IR if needed) and high resolution (720 lines of resolution or greater). All camera models must be approved by FS Lock & Door Shop.
   b. Have vari-focal lenses and auto-iris to allow for field-of-view optimization and ability to automatically adjust to changing lighting conditions. Lenses shall be those recommended by camera manufacturer.
   c. Be powered over limited energy conductors from a central power supply mounted in the communications closets of Point of Entry.
   d. Mini-dome cameras are to be used at elevator cab ceilings. Elevator Subcontractor will install coax cable in elevator traveling cable. CCTV Contractor shall run cable from elevator machine rooms to DVR / NVR and monitor. Coordinate camera installation in elevators with elevator installer.
   e. Inventory of cameras may include: areas with cash handling equipment; bike storage; primary entries; stairwells; etc. Camera inventory and locations will be determined by each project and require FS Lock & Door Shop review and approval.
4. The CCTV system shall be equipped with FS Lock & Door Shop specified number of cameras.

5. Surveillance Products: The appropriate product models are to be approved by designated FS Lock & Door Shop during project design and specification.

### PART 2 PRODUCTS

<table>
<thead>
<tr>
<th>Surveillance Product</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Note(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Video Recorder</td>
<td>AMAG stand alone NVR or DELL server</td>
<td></td>
<td>Where applicable NVR system and equipment are requested and specified.</td>
</tr>
<tr>
<td>Exterior Color Camera</td>
<td>Panasonic or Sony</td>
<td>To be approved</td>
<td>Weatherproof. Or approved equal.</td>
</tr>
<tr>
<td>Exterior Color Camera</td>
<td>Panasonic or Sony</td>
<td>To be approved</td>
<td>Weatherproof. Or approved equal.</td>
</tr>
<tr>
<td>IP Cameras</td>
<td>AXIS or approved</td>
<td></td>
<td>IP cameras must be compatible with AMAG NVR Solutions.</td>
</tr>
<tr>
<td>Cameras</td>
<td>ALL</td>
<td>ALL</td>
<td>At least 720 lines of TV resolution during normal lighting conditions. Low-light cameras may switch to black &amp; white in low lux conditions. See also, previous system.</td>
</tr>
<tr>
<td>Camera Power Supply</td>
<td>Altronix</td>
<td></td>
<td>16 fused output and 24 VAC. Or approved equal.</td>
</tr>
<tr>
<td>Camera Mounts &amp; Adapters</td>
<td>-</td>
<td></td>
<td>ALL cameras to include necessary mounts and adapters recommended by manufacturer for</td>
</tr>
<tr>
<td>Camera Cable</td>
<td>-</td>
<td></td>
<td>Cat5e or Siamese type depending on</td>
</tr>
<tr>
<td>Security/Burglar Alarm</td>
<td>Radionics, Bosch, or Detection System Control Units</td>
<td>-</td>
<td>Programmable by Bosch RPS software, version 3.7 or later.</td>
</tr>
</tbody>
</table>

### PART 3 EXECUTION

#### 3.01 GENERAL INSTALLATION

A. Quality Assurance: All workers involved with this installation must have completed manufacturer training and have a minimum of 2 years experience installing like equipment or have a minimum of 5 years of installation experience with specified equipment.

B. Install all equipment and cabling in a manner consistent with manufacturer recommendations and instructions.

C. Install all devices and components shown on drawings required for proper operation of the system.

D. Mount devices level and in a uniform fashion.

E. Camera power supplies are to mount in the Point of Entry rooms.

F. Wiring to cameras shall be CAT 5e twisted pair and shall include any necessary components to transmit video and power across CAT 5e cabling.

G. Contractor shall furnish and install all cabling associated with the operation of CCTV system.
ELECTRONIC SURVEILLANCE

H. Contractor shall not pull any CCTV cables in conduits containing or intended to contain voice and data wiring.

3.02 SURVEILLANCE AND INTRUSION SYSTEMS AND EQUIPMENT

A. Coordinate with FS Lock & Door Shop setup of Ethernet network and IP address assignment; camera setup to ensure proper focus and view to satisfaction.

B. When the installation of all system components and cabling is complete, initial testing shall consist of local walk-through, and working demonstration of all features.

C. All passwords or access codes for the system shall remain at factory default unless the factory default poses a security risk, in which case all passwords shall be communicated in writing and give written FS Lock & Door Shop approval of such change. Any costs associated with password recovery shall be borne by the Contractor.

D. The Owner shall be provided with a minimum of 2hrs training of the installed system after all startup and testing procedures have been completed and as-built documentation delivered.
   1. Minimum hours of required training may increase based upon the system size and complexity.
   2. Training will include both an overview for building occupants and an in-depth session for Facilities maintenance to a service level.

G. Prior to FS Lock & Door Shop final acceptance of the system all zones must be tested in the presence of designated representative(s) from the FS Lock & Door Shop.

3.03 SURVEILLANCE AND INTRUSION SYSTEMS CLOSEOUT, WARRANTY, AND SUPPORT

A. With as-builts, record drawings, O&M manuals, etc. deliverables a complete list is required of all system devices, power packs, etc. noting their installed locations.

B. Guarantee all work against faulty and improper material and workmanship for a minimum of 1 year from the date of final written acceptance by FS Lock & Door Shop, except where guarantee or warranties for longer terms are clearly requested and specified.

C. During the entire warranty period the Contractor must provide all related software upgrades to the installed system(s).

D. Upon notification of a problem, the warranty provider shall furnish within 48 hours at no cost to the Owner such labor and materials as are needed to restore the system to proper operation.

E. During the entire warranty period the Contractor must guarantee a 4 hour response time for problem resolution.

F. Prior to the end of the warranty period, with FS Lock & Door Shop present, the Contractor is to conduct a 1 year inspection and provide a report of system equipment and system operational functions.
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. The purpose of this Section is to define the scope of work upon which the fire alarm contractor, hereafter known as Contractor, is to base his bid, to establish the design and installation criteria to be used, and to define design submittals which will be required in the preparation and execution of the design.

1.2 SCOPE

A. Contractor Performance Requirements

1. This specification and the drawings provide the requirements for the design, installation, programming and configuration of a complete addressable intelligent fire alarm system network. The system shall include, but not limited to: Control Panel(s), automatic and manually activated alarm initiating and indicating peripheral devices and appliances, signage, auto-dialers (if required), associated connections, conduit, wire and accessories as indicated in this specification and on associated drawings and as required to furnish a complete and operational fire alarm system. Provide all labor, materials, tools, instructions, data, testing/test results, and reports, spare parts, equipment and design services as required.

2. System shall be designed in accordance with rules, regulations and standards as required by the federal, state and local governing agencies. Even if not particularly specified, all code or county required items or amendments shall be incorporated in the design, furnished, and installed by the Contractor without additional expense to the Owner.

3. Submission to Authority Having Jurisdiction (AHJ): In addition to routine submission of the material, make an identical submission to the authority having jurisdiction. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, submit them to Architect, Owner and Electrical Engineer for review. Provide written response to the AHJ’s review comments and provide resubmissions with clarifications or revisions as required to obtain approval. Contractor shall meet with appropriate city and county representatives before final construction documents are completed to insure system will pass all city and county plan inspections. Change orders will not be accepted for items that should have been included in the design.

4. The Contractor shall be the Engineer of Record and shall assume total responsibility for their systems, including permits, products, installation, and performance.

5. The Contractor is responsible for design and preparation of shop drawings and shall identify all such work in the process of design and preparation of construction documents.

6. Fire alarm system infrastructure capacity to be adequate to support a typical full tenant improvement build-out.

B. Project Phasing and Coordination

1. Coordinate project phasing with general contractor. Provided additional equipment and labor required to accommodated project phasing.

2. Connect Craft Center fire devices to new Notifer fire alarm system.

C. Related Sections include the following:

1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (DESIGN-BUILD)

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

1.5 FIRE ALARM SYSTEM PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

B. Provide speakers adequate for high ambient noise areas in the craft center.

C. Provide heat detectors in areas with high dust issues and hi-temp detectors around equipment with high operating temperatures.

1.6 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product indicated.

C. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire alarm system design.
   b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

3. Device Address List: Coordinate with final system programming. Device address list shall be the architectural room number of device is in or the door number of the nearest the device if located on a hallway or corridor.

4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.

5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.


7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Qualification Data: For Installer.

E. Field quality-control test reports.
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (DESIGN-BUILD)

F. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

G. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

H. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, and Architect. Format of the written sequence of operation shall be the optional input/output matrix.
   a. Hard copies on paper to Owner, and Architect.
   b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

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. NFPA Certification: Obtain certification according to NFPA 72.

1.8 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
   2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
   3. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
   4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
   5. Keys and Tools: One extra set for access to locked and tamperproofed components.
PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Notifier; a Honeywell company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION
A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Heat detectors in elevator shaft and pit.
7. Fire-extinguishing system operation.

B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Unlock electric door locks in designated egress paths.
4. Release fire and smoke doors held open by magnetic door holders.
5. Activate voice/alarm communication system.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Recall elevators to primary or alternate recall floors.
9. Record events in the system memory.

C. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

D. System Trouble and Supervisory Signal Actions: Initiate notification appliance and announce at fire-alarm control unit and remote annunciators. Record the event on system printer. Report the event to the campus fire loop.

2.3 FIRE-ALARM CONTROL UNIT
A. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
   a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.
2. Addressable initiation devices that communicate device identity and status.
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (DESIGN-BUILD)

a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.

b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 40 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits: Select circuit Class per NFPA 72.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.

2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.

3. Record events by the system printer.

4. Sound general alarm if the alarm is verified.

5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Notification Appliance Circuit: Operation shall sound in a thermal pattern.

F. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall.
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine rooms.
   c. Smoke detectors in elevator hoistways.

2. Elevator lobby detectors located on the designated recall floor shall be programmed to move the cars to the alternate recall floor.

3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (DESIGN-BUILD)

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Cat 15 Key-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated.
6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).

B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A and NFPA 90A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Duct smoke detectors are to be mounted downstream of the supply fan to the exterior housing of the duct and shall be equipped with air sampling tubes. No in duct type detectors will be accepted.

6. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide sampling tubes running the full width of the duct in the center of the air stream.

7. Provide detectors with a visible indicator that shows when the unit is in an alarm condition. Provide a remote visible indicator for detectors located in concealed locations such as above a ceiling, over six feet from the finished floor, etc.

8. Auxiliary contacts: Rated to provide control, interlock and shutdown function for HVAC equipment.

E. HEAT DETECTORS


2. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

3. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
   b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

### 2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (DESIGN-BUILD)

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
1. Rated Light Output:
   a. 15/30/75/110 cd, selectable in the field.
2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.

2.7 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.8 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

2.9 SYSTEM PRINTER

A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

2.10 MECHANICAL EQUIPMENT

A. Refer to specification section 23900 for a list of equipment that require a fire alarm interface connection.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Smoke- or Heat-Detector Spacing:
   3. Smooth ceiling spacing shall not exceed the rating of the detector.
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

K. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 CONNECTIONS
A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

3.3 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING
A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL
A. Field tests shall be witnessed by Architect and authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (DESIGN-BUILD)

b. Comply with “Visual Inspection Frequencies” Table in the “Inspection” Section of the “Inspection, Testing and Maintenance” Chapter in NFPA 72; retain the “Initial/Reacceptance” column and list only the installed components.


3. Test audible appliances for the public operating mode according to manufacturer’s written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test visible appliances for the public operating mode according to manufacturer’s written instructions.


D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Clearing and protection of vegetation.
B. Removal of existing debris.

1.2 LEED REQUIREMENTS
A. LEED Project Goals: See Section 01 81 13 - Building and Site LEED Requirements.
B. Requirements of the following LEED credits are mandatory for the work of this Section in order to achieve LEED certification:
   1. Materials and Resources Credit 4 - Recycled Content.
C. Requirements of the following LEED credits contribute cumulatively toward LEED certification:
   1. Materials and Resources Credit 4 - Recycled Content.
D. Submittals: Submit required LEED documentation for Mandatory and Contributing credits.

PART 2 PRODUCTS
2.1 NOT USED.

PART 3 EXECUTION

3.1 SITE CLEARING
A. Comply with other requirements specified in Section 01 70 00.
B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.2 EXISTING UTILITIES AND BUILT ELEMENTS
A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
B. Tunnels and buried utilities must be located prior to jack-hammering, excavation, etc. If tunnel ceiling damage occurs this must be repaired at Contractor's expense in a manner approved by Owner.
C. Protect existing utilities to remain from damage.
D. Do not disrupt public utilities without permit from authority having jurisdiction.
E. Protect existing structures and other elements that are not to be removed.

3.3 VEGETATION
A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.
B. Do not begin clearing until vegetation to be relocated has been removed.
C. Do not remove or damage vegetation beyond the limits indicated on drawings.
D. Install chainlink fences at least 6 feet high to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
   3. Around other vegetation to remain within vegetation removal limits.
   4. See Section 01 50 00 for temporary fence construction requirements.
E. Removed Vegetation: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees:
SITE CLEARING

a. All trees to be removed over 6-inches caliper are to be individually posted for removal at least 2-weeks prior to removal. Postings to include Project Manager information.

b. Coordinate posting of trees to be removed with Owner's Representative. Trees to be removed within project fencing are to be posted on outside of Construction Fencing. Trees to be removed outside of project fencing are to be individually posted.

c. Coordinate with Owner's Representative for lumber that should be delivered to UO Facilities Services for milling and salvaging.

3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.

4. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.4 DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
A. Work of this section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
A. Excavation and fills, including compaction, of on-site building, pavement, and landscaped areas.

1.3 RELATED SECTIONS
A. Section 01 23 00 - Alternates
B. Section 00 31 00 - Available Information (Geotechnical Report)
C. Section 31 23 33 - Trenching and Backfill

1.4 REFERENCED SPECIFICATIONS
A. ODOT Standard Specifications (latest revision).

1.5 REFERENCED DOCUMENTS
A. Geotechnical Report: Geotechnical Investigation and Site-Specific Seismic Hazard Study, Erb Memorial Union Expansion and Renovation, University of Oregon, August 16, 2013.
B. All earthwork operations shall comply with the recommendations and requirements of the Geotechnical Report.

1.6 DEFINITIONS
A. Rock: Material that cannot be removed by one-yard shovel, by backhoe with 9,500 lb. digging force, by pick and shovel, or by 200 HP Crawler fitted with normal excavating equipment. Ripper attachment as might be hooked into seam is not considered "normal" excavating equipment.
B. Unstable Soil: Soft, loose, wet, or disturbed ground that is incapable of supporting material, equipment, personnel, or structure.
C. Wet Weather Conditions: Wet Weather Conditions apply to materials placed during dry weather but which are subsequently subjected to rainfall and equipment or construction traffic. The Contractor shall be responsible for the performance of the selected type of material.

1.7 SUBMITTALS
A. Comply with Section 01 33 00, unless otherwise noted.
B. Product Data: Manufacturer's specifications and technical data including performance, construction, and manufacturing information.
C. Bio-Retention Soil Submittals
   1. Grain size analysis results of the Aggregate component of the bio-retention soil mix.
   2. Quality analysis results for the Compost component of the bio-retention soil. At a minimum, the analysis and report shall document compliance with the requirements specified herein.
EARTH MOVING

Analysis report shall bear the US Composting Council's (USCC) "Seal of Testing Assurance", and shall comply with the "Testing Methods for the Examination of Compost and Composting" (TMECC).

3. Permeability testing by independent laboratory.
4. Organic content test results of the blended bio-retention soil mix.
5. A five gallon sample of the Aggregate component, Compost component, and final bio-retention soil mix for Architect's review. Store sample at jobsite.
6. A written description of the equipment and methods used to mix the Aggregate component with the Compost component used to produce the final mix. Include calculations for volumetric quantities used in the mix.
7. Testing laboratory information: Name of laboratories including contact persons, address, phone number, and email address.

D. Rock Protection Submittals:
   1. Submit sample of material for Architect's review and approval. Store sample at jobsite.

E. Samples: Submit _____ material sample(s) (2 quart minimum) of the following product for approval prior to delivery to site.

F. Field Quality Control: Submittals as specified in Part 3 of this section.
   1. Field Tests.
   2. Special Inspections for Code Compliance.

G. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
   1. Provide record documents.

1.8 QUALITY REQUIREMENTS

A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.

B. Installers Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

C. Product/Material Qualifications:
   1. Design Data: Compaction testing shall be in accordance with Section 01 45 00, QUALITY CONTROL.
   2. Test Reports: Provide imported material gradation test reports. Provide material compaction test reports.

D. Regulatory Requirements:
   1. An erosion control permit is required. The Owner shall apply, pay for, and secure the permit. The contractor shall comply with the construction erosion control permit.
   2. Observation and Inspection: Owner will retain a Geotechnical Engineer to monitor earthwork operations.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.10 ADVANCE NOTICES

A. Notify Engineer at least 48 hours before starting work of this section.

B. Coordinate Geotechnical Engineer's observation of all prepared subgrade and all compaction efforts.
1.11 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 STABILIZATION FILL FOR CONSTRUCTION HAUL ROADS OR OTHER HIGH DENSITY CONSTRUCTION TRAFFIC AREAS

A. Imported, clean, fragmented quarry rock, up to 6-inch nominal size material, open-gradation.

2.2 STRUCTURAL FILL (FOR BUILDING PAD, WALKWAYS, AND PAVEMENTS)

A. Imported clean crushed rock or crushed gravel, maximum size of 2 inches, free from foreign material and no more than 5% passing the No. 200 sieve.

2.3 CRUSHED ROCK FILL (FOR BUILDING PAD, WALKWAYS, AND PAVEMENTS)

A. Imported clean 3/4" -0 or 1-1/2" - 0 crushed rock or crushed gravel, free from foreign material and conforming to the requirements of ODOT Standard Specification (latest revision) 02630.

2.4 OPEN-GRADED CRUSHED ROCK FILL

A. Imported, clean 3/4" - 1/4" angular, crushed rock or crushed gravel, free from foreign material with no more than 2 percent passing the No. 200 sieve.

2.5 NATIVE MATERIAL FOR REUSE IN LANDSCAPE AREAS

A. Excavated, on-site soil, native to project site, free of organics, solids larger than 3 inch diameter, weeds and other deleterious matter and approved by the Geotechnical Engineer for use as fill only during dry weather conditions, and only in landscape areas.

2.6 IMPORTED TOPSOIL

A. Refer to Section 32 90 00 PLANTING.

2.7 SUBGRADE STABILIZATION GEOTEXTILE

A. Subgrade woven geotextile; grab tensile strength 200 lb minimum per ASTM D4632 (latest revision) each direction; burst strength 400 psi per ASTM D3786 Mod. (OSHD TM814) (TF 25. Method 3); puncture strength 75 lb per ASTM D4833 (latest revision) or ASTM D3787 Mod. (OSHD TM 816); No. 40 sieve per ASTM D4751 (latest revision) or smaller opening; 0.05 sec water permittivity per ASTM D4491 (latest revision). Propex Geotex 200ST or approved.

B. Erosion Control geotextile; grab tensile strength 100 lb minimum per ASTM D4632 (latest revision) each direction; burst strength 300 psi per ASTM D3786 Mod. (OSHD TM814) (TF 25. Method 3); puncture strength 60 lb per ASTM D4833 (latest revision) or ASTM D3787 Mod. (OSHD TM 816); No. 30 sieve per ASTM D4751 (latest revision) or smaller opening; 0.1 sec water permittivity per ASTM D4491 (latest revision). Mirafi 100X or approved.

2.8 CONDUIT

A. Irrigation sleeves as specified in Section 32 80 00, IRRIGATION.

B. Electrical conduit as specified in Division 26, ELECTRICAL.
2.9 BIO-RETENTION SOIL

A. Minimum Soil Properties Used as Basis of Design:
   1. Cation Exchange Capacity: 5 meq/100 grams of dry soil.
   2. Percent Organic Matter per ASTM D2974 or TMECC 05.07A: 4-10%
   3. Permeability: TBD.
   4. Compost Content (Volumetric Percent): 40%
   5. Aggregate Content (Volumetric Percent): 60%
   6. Aggregate Gradation per ASTM D 422:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 10</td>
<td>75 - 90</td>
</tr>
<tr>
<td>No. 40</td>
<td>25 - 40</td>
</tr>
<tr>
<td>No. 100</td>
<td>4 - 10</td>
</tr>
<tr>
<td>No. 200</td>
<td>2 - 5</td>
</tr>
</tbody>
</table>

   7. Aggregate Coefficient of Uniformity per ASTM D 422: 4 or greater.

   8. Compost Characteristics:
      a. Compost material properties shall be tested in accordance with the US Composting
         Council’s (USCC) "Seal of Testing Assurance", in accordance with the TMECC.
      b. Material to comply with Oregon Administrative Rules Section 340-093-0030, and be
         made from Type 1 feedstock.
      c. Particle Size:

         | Sieve Size | % Passing |
         |------------|-----------|
         | 1”         | 99 - 100  |
         | 5/8”       | 90 - 100  |
         | ¼”         | 40 - 90   |

d. Organic matter content between 45 and 60 percent.

e. pH between 5.5 and 8.0.
g. Maximum electrical conductivity of 6 mmhos/s.
h. Moisture content range between 35 and 50 %.
i. No viable weed seeds.
j. Maturity: 80 % or greater
k. Stability: 7 mg CO2-C/g or less
l. Manufactured inert material (plastic, concrete, ceramics, etc.) should be less than 1%
   on a dry weight or volume basis.
m. Metals should not be in excess of the limits described in the Oregon Administrative
   Rules Section 340-093-0030.

   9. Submit documentation of compost, aggregate, and final soil mix properties for
      Engineer’s review.

   9. Submit documentation of compost, aggregate, and final soil mix properties for Engineer’s
      review.
2.10 BIO-RETENTION FILTER SAND

A. ASTM C33 Specification Fine Aggregate (Concrete Sand) meeting the following parameters:
   1. \( D_{15} = 0.3 \) mm
   2. \( D_{50} = 0.75 \) mm
   3. \( D_{85} = 2 \) mm
   4. \( C_u = 4 \)

B. Filter sand gradation may be adjusted depending on the locally available bio-retention soil mix.

2.11 BIO-RETENTION FILTER PEA GRAVEL

A. Imported, washed, No. 8 aggregate per ASTM C33.

2.12 BIO-RETENTION DRAIN ROCK

A. Imported, double washed, No. 57 aggregate per ASTM C33.

2.13 BIO-RETENTION MULCH

A. Imported, clean, double-washed, round river rock material, 1"-1/2" size range, uniform color range as approved by Architect.

2.14 IMPERMEABLE LINER

A. Manufacturer:
   1. RPE 25 by Layfield or approved equal.

B. Material: Liner shall be UV resistant and shall have the following average properties (values from individual rolls should not vary from these values by more than +/−10%)

<table>
<thead>
<tr>
<th>Property</th>
<th>test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>Nominal Thickness</td>
<td>20 mils</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM d5034</td>
<td>340 lbs.</td>
</tr>
<tr>
<td>Tear Strength</td>
<td>ASTM d2261</td>
<td>125 lbs.</td>
</tr>
<tr>
<td>Accelerated Weathering/UV</td>
<td>ASTM g53-84</td>
<td>More than 80% strength</td>
</tr>
<tr>
<td>Burst Strength</td>
<td>ASTM d3786</td>
<td>551 psi</td>
</tr>
</tbody>
</table>

C. Accessories:
   1. Tape: As approved by the manufacturer
   2. Pipe Adapters: As recommended and approved by the manufacturer.

2.15 ROCK PROTECTION AT OUTFALLS AND SCUPPERS

A. Provide in accordance with Section 32 90 00.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting of the work of this section verify that existing grades and field conditions agree with drawings. Notify Engineer of deviations.

B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.
C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 PROTECTION

A. Monuments: Carefully maintain bench marks, monuments, and other reference points. If disturbed or destroyed, replace as directed.

B. Existing Utilities: Existing utilities shall be field located. Protect active utility lines encountered. Repair or replace utility lines damaged by work of this Section.

C. Pavement Cleaning: Maintain pavements and walkways clean at all times.

D. Dust Control: Protect persons and property against damage and discomfort caused by dust; water as necessary and when directed.

E. Other Work and Adjacent Property: Protect against damage caused by work of this section.

3.3 GENERAL REQUIREMENTS

A. Contractor shall perform all excavation necessary or required for proper construction of the work and placement or installation of materials.

B. Cutting Pavements: Cut vertical, straight-line joints using power saw designed for cutting pavements.

C. Line and Grade: Excavate to lines and grades shown on the drawings or as established by the Engineer.

D. Shoring: Shore excavations when necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, utilities, property, workers, and the public or as required by local, state, or federal agencies. Shoring shall be removed, as the backfilling is done, in a manner that does not damage work or permit voids in the backfill. It shall be the sole responsibility of the Contractor to see that safety requirements are met. Contractor to retain Oregon-licensed professional engineer experienced in the design of temporary shoring systems.

E. Temporary stockpiling of Excavated Materials: Excavated materials may be placed in approved areas. Do not obstruct roadways, bikeways, or pedestrian walkways. Conform to all federal, state and local codes governing the safe loading of excavated materials adjacent to excavations.

F. Excess Excavation: Where excavation, through the Contractor's error, is carried to levels lower than those shown on drawings, backfill with specified bedding material to proper levels at Contractor's expense.

G. Drainage: Except as otherwise permitted, excavation shall be done in a manner as to provide for adequate drainage. In excavation where gravity drainage is not practical, the Contractor shall provide pumps and accessories with which to remove and dispose of all water, including but not limited to, surface water from rainfall entering the excavations, as required to accomplish the work and as required by governing jurisdictions.

H. Backfilling shall not commence until after excavations have been inspected. Backfill shall be placed in such a manner as not to disturb, damage, or subject such facilities to unbalanced loads or forces. Make fills as soon as feasible after Engineer's review and acceptance.

I. If rock or unstable soil are encountered, notify Engineer. Removal of rock or unstable soil will be paid for as an addition to the contract.

J. Wet Weather Conditions: If construction will extend through wet weather periods, all pavement and building pad cross sections shall be increased to provide a minimum 12”--18” inch crushed
rock working pad for light construction traffic and a 18"-24" crushed rock working pad for heavy construction traffic.

3.4 GEOTEXTILE PLACEMENT

A. Acquisition and Storage: Provide complete rolls of geotextile as furnished by the manufacturer, and protect against damage and deterioration. Store all geotextile rolls in a dry place and off the ground at all times according to ASTM D4873 (latest revision). Cover all rolls and partial rolls with a dark protective covering when received. The geotextile will be rejected for use if the Engineer determines it has defects, deterioration, or has been damaged.

B. Surface Preparation: Prepare the surface receiving the geotextile to a smooth condition free of obstructions, depressions, and debris unless otherwise directed. Do not drag the geotextile on the ground or mishandle it in any way.

C. Loosely place the geotextile without wrinkles so placement of the overlying material will not tear the geotextile. Lap or sew the geotextile at the ends and sides of adjoining sheets as specified.

D. On Slopes: Place the geotextile with the machine direction oriented up-down the slope. Lap the upper sheets over the top of the lower sheets. When the geotextile is placed on a slope steeper than 6:1, securely anchor the laps to the ground surface with pins or stakes as necessary to prevent slippage and tearing of the geotextile. Start placement of fill material on the geotextile at the toe of the slope and proceed upwards.

E. Overlap: Minimum overlap shall be 24 inches.

F. If the Engineer determines the specified overlap is not sufficient, increase the overlap to provide adequate coverage or sew the geotextile together in the field. If field-sewn, the provisions of ODOT 00350.20 and 00350.41(a-3) apply.

G. Protection of Geotextile: Protect the geotextile at all times from ultraviolet (UV) rays, contamination by surface runoff, and construction activities.

H. Traffic or construction equipment will not be permitted directly on the geotextile except as authorized by the Engineer. When placed for construction, cover the geotextile with specified cover material as soon as possible.

I. Place cover material on the geotextile in a manner that the geotextile is not torn, punctured, or shifted. Use a minimum 6-inch-thick cover layer or twice the maximum aggregate size, whichever is thicker. End-dumping cover material directly on the geotextile will not be permitted.

J. Limit construction vehicles in size and weight so rutting in the initial layer above the geotextile is not more than three inches deep or one half the layer thickness, whichever is less. Turning of vehicles on the first layer will not be permitted.

K. Repair of Geotextile: Repair or replace all torn, punctured, or contaminated geotextiles during construction at no cost to the Owner. Repair by placing a patch of the specified geotextile over the affected area. Where geotextile seams are required to be sewn, repair any damaged sheet by sewing unless otherwise indicated on the plans or special provisions or as directed.

3.5 STRIPPING, CLEARING AND GRUBBING

A. Strip, clear and grub site in all building areas, walkways, and other areas to receive structural fill.

B. Stripping and clearing shall be the removal of all existing structures, pavements, brush, grass, shrubs, trees, weeds, rubbish, loose soil, and debris flush with or slightly below original ground surface. Remove willow and blackberry, if any, to not less than 12 inches below original ground surface.
EARTH MOVING

C. Grubbing shall be the removal of all stumps and roots larger than 1-1/2 inches in diameter, rocks larger than 6 inches, and existing structures to the following levels:
   1. To not less than 6 inches below grade or as required to remove brush and tree roots.

D. Refer to Section 31 10 00 SITE CLEARING for disposal of trees and vegetation. Dispose of all material offsite unless otherwise noted.

3.6 EXCAVATION AND FILLS AT PAVEMENT AREAS

A. Excavation equipment and procedures must prevent disturbance and softening of subgrade soils. Site excavation and grading should be completed using a track-mounted hydraulic excavator. Excavation should be finished using a smooth-edged bucket to produce a firm, undisturbed surface.

B. During wet conditions, construction equipment should not traffic fine-grained subgrade (silt) soils. Place 12"-18" depth Stabilization or Structural Fill for a working pad to protect subgrade for lighter construction equipment and limited traffic by dump trucks. Place 18"-24" depth Stabilization Fill for haul roads and other high-density traffic areas with subgrade geotextile.

C. Excavate the existing fill material to the depths of Fill noted in the Geotechnical report and as directed by the Geotechnical Engineer under the direction of the Geotechnical Engineer. Organic fill may be stockpiled on site for later use in landscaped areas with approval of the Geotechnical Engineer and Landscape Architect. Remove all other fill material from site. It may be necessary to excavate several test pits in these areas, especially next to the existing structure to document the extent, thickness, and condition of Fill and determine whether additional overexcavation is necessary to remove soft, loose, deleterious materials.

D. Excavate material in the test pits indicated on the drawings or the Geotechnical Report under the direction of the Engineer and Geotechnical Engineer. Remove material from site. Fill the test pits with Crushed Rock Fill. Place fill in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

E. Excavate any additional existing material to the grades required on the drawings. Remove any additional excavated material from site.

F. Unstable material shall be overexcavated as directed by the Geotechnical Engineer. Overexcavated material shall be removed from site. Use Structural Fill or Crushed Rock Fill to fill the voids left after overexcavation. Place fill in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

G. Increase excavation depth and crushed rock base thickness as required for wet weather working conditions.

H. Place Structural Fill or Crushed Rock Fill to raise the grade to the bottom of the pavement section elevation. Place fill in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

I. Place Crushed Rock Pavement Base. Place base material in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision).

3.7 EXCAVATION AND FILLS AT BUILDING AREAS

A. Excavation equipment and procedures must prevent disturbance and softening of subgrade soils. Site excavation and grading should be completed using a track-mounted hydraulic excavator.
EARTH MOVING

Excavation should be finished using a smooth-edged bucket to produce a firm, undisturbed surface.

B. During wet conditions, construction equipment should not traffic fine-grained subgrade (silt) soils. Place 12"-18" depth Stabilization or Structural Fill for a working pad to protect subgrade for lighter construction equipment and limited traffic by dump trucks. Place 18"-24" depth Stabilization Fill for haul roads and other high-density traffic areas with subgrade geotextile.

C. Excavate the existing fill material to the depths of fill noted in the Geotechnical report and directed by the Geotechnical Engineer under the direction of the Geotechnical Engineer. Organic fill may be stockpiled on site for later use in landscaped areas with approval of the Landscape Architect. Remove all other fill material from site. It may be necessary to excavate several test pits in these areas, especially next to the existing structure to document the extent, thickness, and condition of Fill and determine whether additional overexcavation is necessary to remove soft, loose, deleterious materials.

D. Excavate any additional existing material to the grades required on the drawings. Remove any additional excavated material from site.

E. Unstable material shall be overexcavated as directed Geotechnical Engineer. Overexcavated material shall be removed from site. Use Structural Fill or Crushed Rock Fill to fill the voids left after overexcavation. Place fill in 12-inch maximum loose lifts and compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

F. Increase excavation depth and minimum crushed rock base thickness as required for wet weather working conditions.

G. Building Slab Preparation:
1. In areas where the finished floor elevation is established near or above existing site grades and exterior finished grades:
   a. Place a minimum depth of 8 inches of Open Graded Crushed Rock Fill beneath the concrete slab-on-grade. Place fill in one lift and compact under Geotechnical Engineer’s observation until approved by the Geotechnical Engineer. It shall be the contractor’s responsibility to maintain and repair the building slab base after initial testing and approval.

2. In areas where the structure will be embedded below existing site grades and the finished floor elevation is established below existing site grades and exterior finished grades:
   a. Place a minimum depth of 8 inches of Open Graded Crushed Rock Fill beneath the concrete slab-on-grade. Place fill in one lift and compact under Geotechnical Engineer’s observation until approved by the Geotechnical Engineer. It shall be the contractor’s responsibility to maintain and repair the building slab base after initial testing and approval.
   b. Place a minimum depth of 2 inches of 3/4"-0 Crushed Rock Fill over the Open Graded Crushed Rock Fill. Place fill in one lift and compact under Geotechnical Engineer’s observation until approved by the Geotechnical Engineer. It shall be the contractor’s responsibility to maintain and repair the building slab base after initial testing and approval.

3. Refer to Division 7 for thermal and moisture protection requirements for new slabs on grade and retaining walls.

H. Foundation Preparation:
1. Shallow building foundations shall be established in firm, undisturbed native soil or compacted Structural or Crushed Rock Fill. During wet-weather construction, shallow building foundations founded in fine-grained soils should be supported on a minimum of 3- to 4-inches of 3/4 - 0 Crushed Rock Fill placed in the bottom of footings excavations as soon as
practical. Compact to a minimum density of 95 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent.

2. Embedded walls shall be backfilled with Open Graded Crushed Rock Fill forming a 24-inch drainage blanket from top to bottom against the embedded wall. Fill shall be placed in 9-inch maximum loose lifts and compacted to a minimum density of 93 percent relative compaction, per a maximum dry density of ASTM D698 (latest revision) at an optimum moisture content of ±2 percent. Overcompaction of the backfill shall be avoided. Heavy compactors and large pieces of construction equipment should be kept a minimum distance of 5 feet away from any embedded wall to avoid the buildup of excessive lateral pressures. Compaction close to the walls should be accomplished using hand-operated, vibratory plate compactors.

3.8 EXCAVATION AND FILL AT LANDSCAPED AREAS
A. Refer to landscape drawings and Section 32 90 00, PLANTING.
B. Excavate any additional existing material to the grades required on the drawings. Remove any additional excavated material from site.
C. Prepare grade subgrade per Section 31 22 00 GRADING.
D. Place planting soils and provide finish grading per Section 32 90 00 PLANTING.

3.9 GRADING
A. Perform all earthwork to the lines and grades shown on the drawings. Shape and finish slopes to conform to the lines, grades, and cross sections as shown or approved by the Engineer. Provide positive drainage away from buildings and sidewalks.

3.10 BIO-RETENTION MATERIALS AT STORMWATER RAIN GARDENS AND PLANTERS
A. Do not allow stormwater runoff to enter flow-through basin by sheet flow or piped drainage until contributing drainage area has been stabilized and flow-through basin is fully constructed.
B. Do not operate heavy equipment within flow-through basin after beginning backfilling.
C. Excavate to the subgrade elevation required to meet the elevations shown on the drawings.
D. Place impermeable liner around sides and bottom of flow-through basin as shown on drawings.
E. Place bio-retention drain rock, bio-retention filter pea gravel, and bio-retention filter sand to conform to the lines, grades, depth, and cross-section shown on the drawings.
F. Install perforated pipe within bio-retention drain rock layer as indicated on the drawings. Extend impermeable liner around cleanout and upstream end of perforated pipe to prevent perforated pipe from coming in contact with native soil.
G. Seal all pipe penetrations through impermeable liner per manufacturer's recommendations.
H. Place bio-retention soil loosely with a conveyor belt unless otherwise approved by the Architect.
I. Bio-retention soil placement shall not occur when bio-retention soil is excessively wet, as determined by the Architect.
J. Bio-retention soil shall not be placed until associated submittals have been reviewed and approved.
K. Consolidate bio-retention soil using water-consolidation or other approved methods. Water consolidation shall be performed in a controlled manner, such that no scour, erosion, or soil...
EARTH MOVING

Displacement occurs. Repeat as needed to reach finished grade. Bio-retention soil shall not exceed 80% relative compaction per ASTM D1557.

L. Coordinate planting work and schedule with bio-retention soil placement. Refer to Section 32 90 00 for planting requirements.

M. Where excavations for shrubs or trees extend into bio-retention drain rock zones, lay filter fabric at the interface between drain rock and tree and shrub excavation. Filter fabric shall not extend higher than drain rock layer.

3.11 IMPERMEABLE LINER

A. Place in as detailed on Drawings.

B. Acquisition and Storage: Provide complete rolls of liner as furnished by the manufacturer, and protect against damage and deterioration. Store all liner rolls in a dry place and off ground at all times according to ASTM D4873. Cover all rolls and partial rolls with a dark protective covering when received. The liner will be rejected for use if the Architect determines it has defects, deterioration, or has been damaged.

C. Surface Preparation: Prepare the surface receiving the liner to a smooth condition free of obstructions, depressions, and debris unless otherwise directed. Do not drag the liner on the ground or mishandle it in any way.

D. Installation: The subgrade surface is to be uniform and free of rocks, depressions, voids, and irregularities that might damage liner. Install impermeable liner in accordance with liner manufacturer’s written recommendations.

1. The liner should be placed in the perimeter trench first. The trench liner should be separate from the liner on the field. Overlap field and trench sections a minimum of 18” in the direction of water flow.

2. Overlap joints a minimum of 8 inches. All laps shall be overlapped in direction the water flows.

3. Continuously tape all joints to provide an impermeable liner.

4. Place a suitable amount of ballast on the liner to prevent movement by wind. The ballast shall be in a form that will not damage liner.

5. Direct loading on the fabric by traffic shall not be allowed. A minimum of 4 inches of material cover must be placed prior to traffic.

6. Repair punctured or torn liner by overlapping additional fabric and joining in accordance with manufacturer’s recommendations.

7. The liner must completely line perimeter trench in a continuous manner.

E. Limit construction vehicles in size and weight so rutting in the initial layer above the liner is not more than 3 inches deep or one-half the layer thickness, whichever is less. Turning of vehicles on the first layer will not be permitted.

F. Repair of Liner: Repair or replace all torn, punctured, or contaminated liners during construction at no cost to the Owner. Repair by placing a patch of the specified liner over the affected area. Where liner seams are required to be sewn, repair any damaged sheet by sewing unless otherwise indicated on the plans or special provisions, or as directed.

3.12 MAINTENANCE OF EARTHWORK

A. Contractor shall maintain all earthwork surfaces until all work has been completed and accepted. Such maintenance shall include, but not be limited to, addition of appropriate backfill material to keep backfilled surface smooth, free from ruts and potholes, and suitable for traffic flow.
3.13 DISPOSAL OF WASTE MATERIAL AND EXCESS EXCAVATION

A. Remove from site excess material that is unsuitable for backfilling or stockpiling at the Contractor's expense.

3.14 SETTLEMENT

A. Any settlement in earthwork which occurs during the warranty period and is attributable to construction procedures, such as improper removal of shoring or insufficient compaction, shall be corrected by the Contractor at his own expense. Any piping or facilities damaged by such settlement shall be restored to their original condition at the Contractor's expense.

3.15 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Subgrade compaction testing.
   2. Material compaction testing.
   3. Imported material gradation testing.

C. Field Inspections: Notify Engineer prior to work of this section.

D. Special Inspections for Code Compliance: Obtain building inspector approvals.

3.16 CLEANING

A. Upon completion of the work of this section promptly remove from the working area all scraps, debris, and surplus material.

3.17 PROTECTION

A. Protect all work installed under this section.

B. Replace at no additional cost to Owner, any damaged work of this Section.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of topsoil.
B. Rough grading the site for site improvements.
C. Finish grading.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil:
   1. Soil Material as defined in Section 32 90 00 - Planting.
B. Other Fill Materials: See Section 31 23 23.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.
B. Stake and flag locations of known utilities.
C. Locate, identify, and protect from damage above- and below-grade utilities to remain.
D. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

3.3 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials. Salvage top soil for re-use as practical.
B. Do not remove topsoil when wet.
C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
E. When excavating through roots, refer to Section 01 56 00 - Tree Protection for roots encountered over 1 inch in diameter.
F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.4 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.
B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.
C. Where topsoil is to be placed, scarify surface to depth of 3 inches.
D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.
E. Refer to Section 32 90 00 - Planting for soil placement schedule.
F. Place topsoil during dry weather.
G. Remove roots, weeds, rocks, and foreign material while spreading.
H. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

3.5 TOLERANCES
A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.
B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.6 REPAIR AND RESTORATION
A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

3.7 CLEANING
A. Remove unused stockpiled topsoil. Grade stockpile area to prevent standing water.
B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Excavation and fills, including compaction, of on-site private storm drain, sanitary sewer, manholes, water distribution, and natural gas distribution systems.

1.3 RELATED SECTIONS
   A. Section 01 23 00 - Alternates
   B. Section 31 20 00 – Earth Moving

1.4 REFERENCED SPECIFICATIONS

1.5 DEFINITIONS
   A. Rock: Material that cannot be removed by one-yard shovel, by backhoe with 9,500 lb. digging force, by pick and shovel, or by 200 HP Crawler fitted with normal excavating equipment. Ripper attachment as might be hooked into seam is not considered “normal” excavating equipment.
   B. Unstable Soil: Soft, loose, wet, or disturbed ground that is incapable of supporting material, equipment, personnel, or structure.

1.6 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer's specifications and technical data including performance, construction, and manufacturing information.
   C. Field Quality Control submittals as specified in Part 3 of this Section.
      1. Field Tests
      2. Special Inspections for Code Compliance

1.7 QUALITY REQUIREMENTS
   A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
   B. Installer's Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.
   C. Product/Material Qualifications:
      1. Design Data: Compaction testing shall be in accordance with Section 01 45 00, QUALITY CONTROL.
      2. Test reports: Provide imported material gradation test reports. Provide material compaction test reports.
TRENCHING AND BACKFILL

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Delivery, Storage and Protection: Comply with manufacturer’s recommendations.
      1. Protect from damage by the elements and construction procedures.

1.9 ADVANCE NOTICES
   A. Notify Engineer at least 48 hours before starting work of this section.

1.10 COORDINATION
   A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 CRUSHED ROCK
   A. Imported, clean, 3/4” - 0 crushed rock or crushed gravel, free from foreign material and meeting
      the requirements of ODOT Standard Specifications (current edition) 02630.
   B. To be used for Pipe Base Material, Pipe Zone Material, and Trench Backfill.

2.2 NATIVE MATERIAL
   A. Excavated on-site soil, native to project site, free of organics, solids larger than 3 inch diameter,
      weeds and other deleterious materials and approved by the Geotechnical Engineer for use as on-
      site backfill only during dry weather conditions.

2.3 CONTROLLED DENSITY FILL
   A. Controlled Density Fill (CDF) shall be a mixture of cement, fly ash, aggregates, water and
      admixtures proportioned to provide a non-segregating, self-consolidating, free-flowing and
      excavatable material which will result in a hardened, dense, non-settling fill.
   B. Mix Design: Mix design shall conform to the following. The weights shown are only an estimate of
      the amount to be used per cubic yard of CDF. The actual amounts may vary from those shown if
      approved by the Engineer. The Contractor shall submit additional data to be approved by the
      Engineer.

   Proportions per Cubic Yard
   - Maximum Compressive Strength: 100 - 250 p.s.i.
   - Maximum Mixing Water: 30 - 50 gals.
   - Cement: 30 - 50 lbs.
   - Fly Ash: 200 - 350 lbs.
   - Dry Aggregate: 2700 - 3200 lbs.

   C. CDF used to fill abandoned pipe: The Contractor shall submit certified engineering data, for the proposed mixture to be used, for the following:
      1. 30 and 90 day unconfined compressive strength (C’) tests as described in ASTM D4832 with
         the following exception: cylinders will not be capped.
      2. Yield and dry unit weight additional (ASTM D6103)
      3. Flowability (ASTM D6023)
      4. Removability (Removability Modules RE=<1.0)
      5. Mixture’s components and sources (company and location). Previous test results, on the
         same mixtures using the same components, will satisfy this requirement.
2.4 TRACER WIRE

A. Electrically conductive tracer wire, 18 - gauge, insulated copper or heavier, green in color, or other approved material. To be placed full length of trench with non-metallic pipe.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work of this section, verify that existing grades and field conditions agree with drawings. Notify Engineer of deviations.

B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 PROTECTION

A. Monuments: Carefully maintain bench marks, monuments, and other reference points. If disturbed or destroyed, replace as directed.

B. Existing Utilities: Existing utilities shall be field located. Protect active utility lines encountered. Repair or replace utility lines damaged by work of this section.

C. Pavement Cleaning: Maintain pavements and walkways clean at all times.

D. Dust Control: Protect persons and property against damage and discomfort caused by dust; water as necessary and when directed.

E. Other Work and Adjacent Property: Protect against damage caused by work of this section.

3.3 GENERAL REQUIREMENTS

A. Contractor shall do all trenching and excavating necessary or required for proper construction of the work and placement or installation of materials. Tunneling or jacking shall not be used unless approved in writing by the Engineer.

B. Cutting Pavements: Cut vertical, straight-line joints using power saw designed for cutting pavements. Cut minimum one foot beyond each side of trench.

C. Obstructions: Remove all obstructions encountered within the trench area or adjacent thereto. If requested by Contractor, Engineer may make minor changes in trench alignment to avoid major obstructions, provided such alignment changes can be made without adversely affecting the intended function of the facility. Contractor shall pay any additional costs resulting from such alignment changes.

D. Trenching: Minimum trench width to be 12 inches greater than outside diameter of pipe. Maximum trench width at top of trench shall not be limited except where excess width of excavation would cause damage or create damage to adjacent structures or facilities.

E. Line and Grade: Excavate trench to lines and grades shown on the drawings or as established by the Engineer with proper allowances for pipe thickness and special bedding when required.

F. Shoring: Shore trench when necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public or as required by local, state,
TRENCHING AND BACKFILL

or federal agencies. Shoring shall be removed, as the backfilling is done, in a manner that will not damage pipe or permit voids in the backfill. It shall be the sole responsibility of the Contractor to see that safety requirements are met.

G. Temporary Stockpiling of Excavated Material: Locate at least 2 feet from trench edges. Place excavated material only within approved areas. Do not obstruct roadways, bikeways, or pedestrian walkways. Conform to all federal, state and local codes governing the safe loading of excavated materials adjacent to trenches.

H. Excess Excavation: Where excavation, through Contractor's error, is carried to levels lower than those shown on drawings, backfill with specified bedding material to proper levels at Contractor's expense.

I. Drainage: At all times keep trenches dry. Provide and operate pumping equipment necessary to keep excavations free from standing water. Dispose of water in manner to prevent damage to adjacent property and as required by governing jurisdiction.

J. If rock or unstable soil are encountered, notify Engineer. Removal of rock or unstable soil will be paid for as an addition to the contract.

3.4 EXCAVATION

A. Excavate trenches to the line and grades shown on the drawings.

3.5 BACKFILL

A. Backfilling shall not commence until after pipe, conduit, structures, and other equipment and appurtenances placed in trench or similar excavations have been properly constructed or installed, as applicable, and inspected. Backfill shall be placed in such a manner as not to disturb, damage, or subject such facilities to unbalanced loads or forces. Make fills as soon as feasible after Engineer's review and acceptance.

B. Pipe Base: Place required thickness of Pipe Base Material over full width of trench. Provide uniform bearing under entire length of each pipe.

C. Pipe Zone: Place required thickness of Pipe Zone Material over full width of trench.

D. Above Pipe Zone: Backfill full width of trench to paving subgrade elevation or to within depth of loam in landscaped areas with Trench Backfill.

E. Compaction: Trench backfill shall be compacted in maximum 24 inch lifts to:
   1. 98 percent compaction under pavement areas per ASTM D698 at an optimum moisture content of ±2 percent.
   2. 90 percent compaction elsewhere per ASTM D698 at an optimum moisture content of ±2 percent.
   3. Water settling of trench backfill will not be considered an acceptable compaction procedure.

3.6 MAINTENANCE OF TRENCH BACKFILL

A. Contractor shall maintain all backfilled trench surfaces until all work has been completed and accepted. Such maintenance shall include, but not be limited to, addition of appropriate backfill material above the pipe zone to keep backfilled trench surface smooth, free from ruts and potholes, and suitable for traffic flow.

3.7 DISPOSAL OF WASTE MATERIAL AND EXCESS EXCAVATION

A. Remove from site excess material and that unsuitable for backfilling.
3.8 SETTLEMENT

A. Any settlement in trench backfill which occurs during the warranty period and is attributable to construction procedures, such as improper removal of shoring or insufficient compaction, shall be corrected by the contractor at his own expense. Any piping or facilities damaged by such settlement shall be restored to their original condition at the Contractor's expense.

3.9 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Material compaction testing:
      a. Trench Compaction: A minimum of one field density test shall be conducted on compacted material for every 100 linear feet, or fraction thereof, of trench and for every 3 feet, or fraction thereof, of fill placed.
      2. Imported material gradation testing.

C. Field Inspections: Notify Engineer prior to work of this section.

D. Special Inspections for Code Compliance: Obtain building inspector approvals.

3.10 CLEANING

A. Upon completion of the work of this section promptly remove from the working area all scraps, debris, and surplus material.

3.11 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this section is bound by the Contract Conditions and Division 1, bound herewith, in
      addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Prevention of erosion due to construction activities.
   B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers
      due to construction activities.
   C. Restoration of areas eroded due to insufficient preventative measures.
   D. Compensation of owner fines levied by authorities having jurisdiction due to non-compliance by
      contractor.

1.3 RELATED SECTIONS
   A. Section 02 32 00 - Available Project Information (Refer to Geotechnical Report)
   B. Section 31 20 00 - Earth Moving

1.4 REFERENCED SPECIFICATIONS

1.5 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise noted.
   B. Product Data: No Submittals Required.
   C. LEED Documentation: Document compliance with LEED Sustainable Sites Prerequisite 1 -
      Construction Activity Pollution Prevention. Submit documentation in one of the following two
      forms
      1. Declaration that periodic inspection occurred throughout the construction process and
         written documentation demonstrating that erosion control plan was carried out appropriately.
      2. Date stamped photos which show the implemented measures and any corrective action that
         was taken.
   D. Closeout Requirements: Comply with Section 01 70 00 and Section 01 78 00.

1.6 QUALITY REQUIREMENTS
   A. All measures indicated in this specification may not be required. Contractor responsible for
      implementing erosion and sediment controls adequate to comply with permit requirements.
   B. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of
      specified products.
   C. Installers Qualifications: Firm with not less than 5 years experience in installation of systems
      similar in complexity to those required for this project.
   D. Regulatory Requirements:
1. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained.

2. An erosion control permit is required from the City of Eugene. The Owner shall apply, pay for, and secure the permit. The contractor shall comply with the construction erosion control permit.

3. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.

4. Action Plan: Contractor shall prepare and submit an Action Plan when Erosion and Sediment Control Measures are modified after permit registration is approved. The Action Plan shall identify revisions made to the approved Erosion and Sediment Control Plan, and shall identify corrective actions taken to cease the discharge of sediment into surface waters or stormwater systems. The Action Plan shall be prepared in accordance with the 1200-C Construction Stormwater Permit Registration Guidance document published by Oregon DEQ in June 2006. An Action Plan shall be required under the following circumstances:
   a. Emergency Situations: Emergency change in erosion control measures due to emergency situations, where immediate corrective action is required to cease the discharge of significant amounts of sediment from entering surface waters or nearby properties. In emergency situations, contractor shall take immediate action to correct the stormwater discharge. Contractor shall submit action plan to Architect within 10 calendar days of the discharge identifying the corrective actions taken to cease the discharge.
   b. Non-Emergency Changes Made Once Project is Underway: Submit Action Plan for changes in the project design affecting stormwater discharges, local conditions, project schedule, weather conditions, or other appropriate reasons. Action Plan shall be required for changes to the Erosion and Sediment Control Measures identified in the Drawings, their location, maintenance required, and any other revisions necessary to prevent and control erosion and sediment runoff. Contractor shall submit action plan to Architect DEQ at least 10 calendar days before implementing the revisions.

E. Stormwater Runoff: Control increased stormwater runoff due to disturbance of surface cover due to construction activities for this project.
   1. Prevent runoff into storm sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
   2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.

F. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. Prevent development of ruts due to equipment and vehicular traffic.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

G. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud onto public roads outside site.
   3. Prevent mud and sediment from flowing onto sidewalks and pavements.
   4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

H. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways and storm sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments and relocate on site; comply with requirements of authorities having jurisdiction.
EROSION AND SEDIMENT CONTROL

I. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments and relocate on site; comply with requirements of authorities having jurisdiction.

J. Open Water: Prevent standing water that could become stagnant.

K. Monitoring and Inspection:
   1. Contractor shall be responsible for monitoring the construction erosion control measures and shall make adjustments to measures, in accordance with the drawings and permit, to accommodate changes in earthwork operations and weather conditions.
   2. Contractor shall be responsible for appointing an Erosion Control Inspector. Inspector shall be a person knowledgeable in the principles and practice of erosion and sediment controls, who possesses the skills to assess conditions at the construction site that could impact stormwater quality, is knowledgeable in the correct installation of the erosion and sediment controls, and is able to assess the effectiveness of any sediment and erosion control measures selected to control the quality of stormwater discharges from the construction activity. Erosion Control Inspector shall submit periodic inspection reports as noted on the Drawings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.8 ADVANCE NOTICES

A. Notify Architect at least 48 hours before starting work of this section.

1.9 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 MULCH BIO BERM

A. The compost filter berm material consists of compost or a blend of compost and mulch materials according to the specifications as follows.

B. The filter berm material shall meet particle sizing specifications that when used in a filter berm system are tested in conformance with the outlined methods and scope of ASTM D6459 (latest revision), standard test method for determination of Erosion Controlled Blanket (ECB) Performance in Protecting Hill Slopes from Rainfall Erosion.

C. The compost portion of the filter berm shall be derived from well-decomposed organic matter source produced by controlled aerobic (biological) decomposition that has been sanitized through the generation of heat and stabilized to the point that it is appropriate for this particular application. Compost material shall be processed through proper thermophilic composting, meeting the U.S. Environmental Protection Agency's definition for a 'process to further reduce pathogens' (PFRP). The compost portion shall meet the chemical, physical and biological properties outlined below.
   1. The pH shall be between 5.0 and 8.5 for berms to receive vegetation.
   2. Nitrogen Content: 0.5 - 2.0%.
   3. Soluble Salts: Maximum 5 mmhos/cm.
2.2 SEDIMENT FENCE

A. Sediment Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths.

B. Apparent Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751 (latest revision).

C. Permittivity: 0.05 sec\(^{-1}\), minimum, when tested in accordance with ASTM D4491 (latest revision).

D. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355 (latest revision) after 500 hours exposure.

E. Grab Tensile Strength-Supported: 100 lb-f, minimum, in cross-machine direction; 120 lb-f, minimum, in machine direction; when tested in accordance with ASTM D4632 (latest revision).

F. Grab Tensile Strength-Unsupported: 90 lb-f, minimum, in cross-machine direction; 100 lb-f, minimum, in machine direction; when tested in accordance with ASTM D4632 (latest revision).

G. Color: Manufacturer’s standard, with embedment and fastener lines preprinted.

H. Manufacturers:
   1. BP Amoco, Amoco Fabrics and Fibers; www.geotextile.com.

2.3 BIO-FILTER BAGS

A. Provide minimum size 18" x 6" x 30" plastic mesh bags with 1/2 inch openings filled with approximately 45 pounds of clean, 100% recycled wood-product waste.

2.4 SAND BAGS

A. Provide 24" x 12" x 6" durable, weather-resistant, tightly woven bags sufficient to prevent leakage of filler material. Fill bags with at least 75 lbs. of firmly packed fine pcc aggregate 3/8" - 0 or round 3/8" - 3/16" pea gravel.

2.5 CATCH BASIN INSERT BAG / CURB INLET SEDIMENT DAM

A. Provide prefabricated filter inserts manufactured specifically for collecting sediment in drainage inlets. Include handles and/or fasteners sufficient to keep the insert from falling into the inlet during maintenance and removal of the insert from the inlet. Insert bags shall be included on the Oregon Qualified Products List (QPL) for Type 3 Inlet Protection, or approved. Curb Inlet Sediment Dams shall be included on the Oregon QPL for Type 6 Inlet Protection, or approved.

2.6 COMPOST/ORGANIC SOIL MULCH BLANKET

A. The blanket material consists of compost or a blend of compost and mulch materials according to the specifications as follows.

B. The blanket material shall meet particle sizing specifications that when used in an erosion blanket system are tested in conformance with the outlined methods and scope of ASTM D6459 (latest revision), standard test method for determination of Erosion Controlled Blanket (ECB) Performance in Protecting Hill Slopes from Rainfall Erosion.
EROSION AND SEDIMENT CONTROL

C. The compost portion of the blanket material shall be derived from well-decomposed organic matter source produced by controlled aerobic (biological) decomposition that has been sanitized through the generation of heat and stabilized to the point that it is appropriate for this particular application. Compost material shall be processed through proper thermophilic composting, meeting the U.S. Environmental Protection Agency’s definition for a ‘process to further reduce pathogens’ (PFRP). The compost portion shall meet the chemical, physical, and biological properties outlined below:

1. The pH shall be between 5.0 and 5.5 for blankets to receive vegetation.
2. Nitrogen Content: 0.5 - 2%.
3. Soluble Salts: Maximum 5 mmhos/cm.
4. Compost shall be weed and pesticide free, with manmade materials comprising less than 1%.

2.7 STRAW MULCH COVER

A. Straw mulch for non-hydroseeding applications from bentgrass, bluegrass, fescue or ryegrass, singly or in combination. If grass seed straw is not available within a reasonable distance of the project, straw from barley, oat or wheat may be allowed upon approval of the Agency. Provide straw that is not moldy, caked, decayed, or of otherwise low quality. Submit certification from the supplier that the straw is free of noxious weed seeds or plant parts. Acceptable documentation will show either (1) that the straw source is from an “Oregon Certified Seed” field, or (2) the seed lab test results of the seed harvested from the straw meet minimum Oregon Certified Seed quality for weed seed content. Use a straw binder or tackifier.

2.8 EROSION BLANKET

A. Erosion blanket to be Type 2, straw and coconut. Furnish blanket consisting of undyed, untreated, biodegradable, jute, coconut coir, synthetic polypropylene fibers, or approved yarn woven into a plain weave mesh with 5/8- to 1-inch square openings. Ensure material conforms to the following:

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification Minimums</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw 70% *</td>
<td>Straw and Coconut mass to be 0.5 lb/sy (0.25” minimum thickness)</td>
</tr>
<tr>
<td>Coconut 30%</td>
<td>Photodegradable netting on bottom side. 5/8 to 1-inch square mesh** with a 0.3 oz/sy weight.</td>
</tr>
<tr>
<td>Netting</td>
<td></td>
</tr>
</tbody>
</table>

* Moisture content shall not exceed 20%.
** Dimensions are approximate and may vary to meet manufacturer’s standards.

Contech’s 70% straw / 30% coconut meets these requirements.

2.9 HAY BALES

A. Air dry, rectangular straw bales.
B. Cross Section: 14 by 18 inches, minimum.
C. Bindings: Wire or string, around long dimension.
D. Bale Stakes: Minimum 3 feet long, steel U- or T-section, with minimum mass of 1.33 lb. per linear foot, or wood, 2” x 2” in cross section.

PART 3 - EXECUTION
3.1 EXISTING CONDITIONS

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Architect prior to starting work of this section.

3.2 INSTALLATION OF EROSION AND SEDIMENT CONTROL MEASURES

A. Install as shown on drawings, or as directed by Architect, Erosion and Sediment Control Inspector, or Local Authority Having Jurisdiction. All measures included in this specification or details shown on Drawings may not be necessary. Contractor to utilize measures, as needed, to meet the requirements of erosion control permit(s) and the intent of this specification.

3.3 EROSION CONTROL BLANKET

A. Install per manufacturer’s specifications. Assure blanket overlap and staple frequency meet manufacturer’s application guidelines. Apply seed to cut slope prior to blanket installation.

3.4 PROTECTION

A. Monuments: Carefully maintain bench marks, monuments, and other reference points. If disturbed or destroyed, replace as directed.

B. Existing Utilities: Existing utilities shall be field located. Protect active utility lines encountered. Repair or replace utility lines damaged by work of this Section.

C. Pavement Cleaning: Maintain pavements and walkways clean at all times.

D. Dust Control: Protect persons and property against damage and discomfort caused by dust; water as necessary and when directed.

E. Other Work and Adjacent Property: Protect against damage caused by work of this section.

3.5 FIELD QUALITY CONTROL

A. Refer to Section 01 40 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Special Inspections for Code Compliance:
   1. Obtain building approvals from Local Authority Having Jurisdiction.
   2. Provide periodic inspection reports as noted on the Drawings.

3.6 MAINTENANCE

A. Maintain temporary measures until permanent measures have been established.

B. Repair deficiencies immediately.

3.7 CLEANING

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
ERSION AND SEDIMENT CONTROL

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

3.8 PROTECTION

A. Protect all work installed under this section.

B. Replace at no additional cost to Owner, any damaged work of this Section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Asphaltic concrete pavements, and crushed rock pavement base for on-site private improvements.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
   A. Section 31 20 00 – Earth Moving

1.4 REFERENCED SPECIFICATIONS

1.5 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer's specifications and technical data including performance, construction, and fabrication information.
      1. Submit for job mix formulas (JMF).
   C. Field Quality Control submittals as specified in Part 3 of this Section:
      1. Field Tests.
   D. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
      1. Special warranties
      2. Provide record documents.

1.6 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
   B. Installer's Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.
   C. Pre-installation Conference: Contractor, installer, Engineer, and representatives of other affected trades shall meet at site to review paving operations, acceptance of substrata surfaces, and coordination with other trades.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Delivery, Storage and Protection: Comply with manufacturer’s recommendations.
      1. Protect materials and maintain product temperature during delivery.
FLEXIBLE PAVING

1.8 SPECIAL WARRANTIES

A. Contractor shall warrant installed pavement for a period of 2 years from date of Substantial Completion. When notified in writing from Owner, they shall promptly and without inconvenience and cost to Owner correct said deficiencies to comply with requirements.

1.9 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

1.10 ADVANCE NOTICES

A. Notify Engineer at least 48 hours before starting work of this section at each site.

PART 2 - PRODUCTS

2.1 CRUSHED ROCK PAVEMENT BASE

A. Under Dense Graded HMAC Mixture: Imported Clean 3/4"-0 or 1-1/2"-0 dense graded crushed rock or crushed gravel, free of foreign material and meeting the requirements of ODOT Standard Specifications (current edition) 02630, Base Aggregate.

B. Under Open Graded HMAC Mixture: Imported Clean 3/4"-0 or 1-1/2"-0 open graded crushed rock or crushed gravel, free of foreign material and meeting the requirements of ODOT Standard Specifications (current edition) 02630, Base Aggregate.

2.2 HOT MIXED ASPHALT CONCRETE (HMAC)

A. Asphalt Mixture: The asphalt concrete mixture shall be a well-graded, uniform coated, durable mix of the mix type(s) as shown on the plans or approved by the Engineer.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage of Total Aggregate (by weight) 1/2&quot; Dense</th>
<th>Percentage of Total Aggregate (by weight) 3/4&quot; Dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>--</td>
<td>99-100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>99-100</td>
<td>92-100</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>90-100</td>
<td>75-91</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>52-80</td>
<td>50-70</td>
</tr>
<tr>
<td>No. 10</td>
<td>21-46</td>
<td>21-41</td>
</tr>
<tr>
<td>No. 40</td>
<td>8-25</td>
<td>6-24</td>
</tr>
<tr>
<td>No. 200</td>
<td>3-8</td>
<td>2-7</td>
</tr>
<tr>
<td>Asphalt Cement</td>
<td>4-8</td>
<td>4-8</td>
</tr>
</tbody>
</table>


FLEXIBLE PAVING

E. Mineral Filler: Finely ground particles of limestone, hydrated lime, or other mineral dust, free of foreign matter.


2.3 JOB MIX FORMULA (JMF)

A. Mix Formula: The Contractor shall submit a JMF for each mixture to be used on the project and meeting the Level 2 criteria of Oregon Standard Specifications for Construction, Current Edition.

B. The Contractor shall supply the job mix design to the Engineer ten (10) work days prior to production. The job mix formula shall be no more than five (5) years old.

C. Approval: No paving shall occur until the Contractor receives written approval of the Contractor's job mix formula.

2.4 HMAC ACCEPTANCE

A. The mixture will be accepted by visual inspection of the Engineer. If the mixture is considered suspect, the Contractor shall obtain samples under the observation of the Engineer and tested as per Oregon Standard Specifications for Construction, Current Edition (section 00744.16). Testing shall be performed by an independent testing agency paid for by the Contractor. Contractor to be reimbursed by Owner if testing shows HMAC is within the specified limits and tolerances.

2.5 HMAC PRODUCTION QUALITY CONTROL/ASSURANCE

A. As specified for Level 2 HMAC in the Oregon Standard Specifications for Construction, Current Edition. Submit the appropriate documentation/reports to Engineer for review.

2.6 MODIFICATION OF MIXES

A. Modification: The Engineer reserves the right to modify specified mixes for use under various traffic conditions on various segments of the work and for feathering, spot patching, and other special purposes. The Contractor shall provide mixes proportioned as directed by the Engineer for such purposes.

2.7 PAVEMENT MARKINGS

A. Traffic paint shall be white traffic marking paint, unless otherwise noted on drawings, two (2) coats, 18.0 mil minimum dry film thickness, Sherwin Williams, Benjamin Moor, Rodda, or approved.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting the work of the section verify that existing grades and field conditions agree with drawings. Notify Engineer of deviations.
FLEXIBLE PAVING

B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 WEATHER LIMITATIONS

A. Surface Temperature: Asphalt concrete shall be placed on a dry prepared surface when the surface temperature is not less than specified below.

<table>
<thead>
<tr>
<th>Nominal Specified Compacted Thickness of Individual Courses</th>
<th>2&quot; to 2-1/2&quot;</th>
<th>2-1/2&quot; and over</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>50°F</td>
<td>40°F</td>
</tr>
</tbody>
</table>

B. Weather: Asphalt concrete shall not be placed during rain or other adverse weather conditions. However, if approved by the Engineer, the mix in transit at the time the adverse conditions occur may be laid if the mix has been covered during transit and is at the specified temperature, if the foundation is free from pools or flow of water, and if all other requirements of these specifications are met. Asphalt concrete mixtures shall not be placed when the foundation is frozen or when, in the opinion of the Engineer, existing or expected weather conditions will prevent the proper handling, finishing, or compaction of the mixtures. Dense and open graded mixes shall only be placed from 3/15 – 9/30.

C. Ambient Temperature Caution: The Contractor is cautioned that placing asphalt concrete on cool days when the temperature is less than 60°F may require an adjustment in Contractor's normal placing and compaction procedures so that specified minimum compaction requirements will be met. The temperatures shown in the table in this section are not recommended temperatures for paving, but paving may be allowed at these temperatures on the condition that specified pavement compaction is achieved.

3.3 ASPHALT CONCRETE PAVING MACHINE

A. Pavers: Pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing layers of asphalt concrete material to the widths thicknesses, lines, grades, and cross sections required.

3.4 COMPACTORS

A. Rollers: Rollers shall be steel wheel, pneumatic tire, vibratory or a combination of these types. They shall be in good condition and capable of reversing without backlash.

3.5 PREPARATION OF FOUNDATION

A. Bases: All bases and foundations on which the pavement is to be constructed shall meet the applicable specifications and be approved prior to the start of paving. Existing bases and foundations shall be reconditioned as specified or directed.

B. Edges: Broken or ragged edges of existing paved surfaces underlying or abutting the new pavement shall be trimmed back to firm material. Surfaces against which asphalt concrete is to be placed shall be treated with an asphalt tack coat.

C. Tack Coat: Prior to placing each lift of asphalt concrete, tack coat asphalt shall be applied to completely cover all cold longitudinal joint and all prepared existing asphalt and portland cement concrete surfaces. Immediately before applying the tack coat, the surface to be tacked shall be
FLEXIBLE PAVING

clean and dry. The application rate shall be between 0.05 and 0.20 gallons per square yard of surface area to achieve uniform, thorough coverage and as approved by the Engineer. Emulsified asphalt temperature to be between 140 and 185°F and application to be in accordance with manufacturer's recommendations.

3.6 CRUSHED ROCK PAVEMENT BASE PLACEMENT

A. Placement and compaction shall conform to the requirements of Section 31 20 00, Earth Moving.

3.7 PLACING ASPHALT PAVEMENT - SINGLE COURSE

A. Place asphalt within 24 hours of applying tack coat. Do not place HMAC pavement on the tack coat until the asphalt separates from the water (breaks), but before it loses its tackiness.

B. Place up to 3 inch compacted thickness in one lift.

C. Install drainage covers and frames in correct position and elevation.

D. Compact pavement by rolling. Do not displace or extrude pavement from position. Use hand-operated compacting equipment in areas inaccessible to rolling equipment.

E. Develop rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.8 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

A. Place asphalt within 24 hours of applying tack coat. Do not place HMAC pavement on the tack coat until the asphalt separates from the water (breaks), but before it loses its tackiness.

B. Place wearing course over base course in two compacted lifts for pavement thicknesses over 3 inches.

C. Place wearing course over base course as soon as possible.

D. Compact pavement by rolling. Do not displace or extrude pavement from position. Use hand-operated compacting equipment in areas inaccessible to rolling equipment.

E. Develop rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.9 CONTROL OF LINE AND GRADE

A. Line and Grade: The Contractor shall furnish, place, and maintain supports, wires, devices, and materials as necessary to provide continuous line and grade reference control to the automatic paver control system on either or both sides of the paving machine.

3.10 HAULING, DEPOSITING AND PLACING

A. Hauling: Cover HMAC if rain or cold air temperatures are encountered any time between loading and placement. Engineer may reject material compromised (below specified temperature, slumping or separating, solidifying or crusting). Rejected loads will be disposed of off-site at the Contractor's expense.

B. Depositing: Material shall be deposited from vehicles to prevent segregation.

C. Placing: Do not place material during rain or other adverse weather conditions, unless allowed by Engineer. Material placed in adverse conditions is to meet all normal contract specification requirements. Material in transit at the time adverse conditions occur may be placed if it has been covered during transport, it is placed in areas free of standing or flowing water, temperature and all other requirements are met.
3.11 TEMPERATURE CONTROL

A. Temperature of Mixture:
   1. The temperature of the mixture at the time it is placed in final position shall be within 10 degrees of 280°F. The Engineer may adjust the lay-down temperature in 10-degree increments to attain maximum workability and compaction. In no case shall the lay-down temperature of mixture be less than 240°F.

3.12 COMPACTION

A. Rolling: Immediately after the asphalt concrete mixture has been spread, struck off and surface irregularities and other defects remedied, it shall be thoroughly and uniformly rolled until the mixture is compacted. Complete breakdown and intermediate compaction before the mix temperature drops below 180°F.

B. General:
   1. The type, number, and weight of rollers shall be sufficient to compact the mixture while it is still within the specified temperature range. Rollers shall not be operated in vibratory mode when the temperature of the mixture has dropped below 180 degrees.
   2. Steel roller wheels shall be moistened with water or other approved material to the least extent necessary to prevent pickup of mixture and not cause spotting or defacement of the surface of the mixture.
   3. Rollers shall be operated at speeds recommended by the roller manufacturer and slow enough to avoid displacement of the mixture. The maximum speeds shall be 3 miles per hour for steel-wheeled rollers and pneumatic-tired rollers, unless faster speeds are approved.
   4. Care shall be exercised not to displace the line and grade of edges. Displacement of any course occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of approved rakes and addition of fresh mixture when required.
   5. Any mixture that becomes loose and broken, contaminated, segregated, or is in any way defective, shall be removed and replaced with new mixture at no expense to the Owner.
   6. Finish rolling shall continue until all roller marks are eliminated.
   7. Along curbs and walls, on walks, irregular areas, and other areas not practically accessible to specified rollers, the mixture shall be compacted with approved self-propelled rollers, mechanical tampers, hot hand tampers, or heavy hand rollers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

C. Density Requirements:
   1. Open Graded HMAC:
      a. Compaction of open graded HMAC to a specified density will not be required.
      b. Use only steel-wheeled roller(s) for compaction. Continue the breakdown and intermediate rolling until the entire surface has been compacted with at least four coverages by the roller(s). Perform additional coverages, as directed, to obtain finish rolling of the HMAC.
   2. The Contractor is responsible for process control and shall conduct sampling, testing, measurement and inspection. The contractor shall provide daily nuclear density testing (ODOT Test Method 310C-87) to develop rolling patterns necessary to achieve the minimum compaction requirement of 91 percent as determined by Rice Density Test AASHTO T 209 as modified by ODOT TM 306. This is in addition to Owner's testing as necessary to ensure the finished pavement meets specifications. A copy of all compaction test reports shall be provided to the Engineer. Contractor to immediately take corrective measures when it is determined that specified compaction density is not achieved. If specified compaction density cannot be achieved the Contractor shall remove and replace the defective asphalt areas at the Contractor’s expense. The Owner has the option of accepting these areas with a reduced payment to the Contractor.
FLEXIBLE PAVING

3. Asphalt compaction below 88 percent as determined by Rice Density Test AASHTO T 209 as modified by ODOT TM 306 is not acceptable.

4. The Architect will determine the suitability of the final product through final acceptance testing. Results of these tests will be used to determine payment deductions, if any to be assessed against the Contract. The final density of each paving project location will be determined by averaging the results of a minimum of five (5) density tests taken with a nuclear gauge (ODOT TM 310C-87) at randomly selected locations within each paving project.

5. Paving in areas 6 feet wide or less and irregular areas not accessible by large rollers are not subject to the minimum compaction per (2) above.

6. The Owner shall take acceptance tests to verify that the work meets specifications.

3.13 PAVEMENT SMOOTHNESS

A. Utility Structures: The joint between the pavement and the top surface of utility structures, such as manhole covers and valve boxes located in the traveled way, shall meet the pavement surface tolerances.

B. Tolerance: The surface of the finished pavement shall be within 0.02 foot of the specified line, grade, and cross section.

C. Texture: The completed surface of all courses of the mixture shall closely parallel that specified for the top surface of the finished pavement and shall be smooth, uniform on texture and conform to the specified crown and grade.

D. Job control testing shall be performed with a 10 foot straightedge furnished and operated by the Contractor. The Engineer may observe this testing, or the Engineer may require additional testing to be performed under the Engineer's supervision. Operations to eliminate the unacceptable pavement shall be corrected by the Contractor using a method or methods listed below and approved by the Engineer.

E. Roughness: When tests show the pavement is not within the above tolerances, the Contractor shall take immediate action to correct equipment or procedures in the paving operations to eliminate the unacceptable pavement roughness.

F. Method of Correction: Any surface irregularities exceeding the above tolerances shall be corrected by the Contractor using a method or methods listed below and approved by the Engineer.

3.14 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Base rock compaction testing.
   2. Asphaltic concrete pavement compaction testing.
   3. Asphaltic concrete pavement gradation testing.

C. Field Inspections: Notify Engineer prior to paving operations.

3.15 CORRECTIVE ACTION

A. Corrective Measures: The Engineer shall require one or more of the following corrective measure be performed on the deficient areas:
   1. Remove and replace the surface course.
   2. Place an overlay of a thickness approved by the Engineer.
FLEXIBLE PAVING

3. Grind the pavement surface utilizing diamond blades up to a maximum depth of 0.3 inch and apply an emulsion fog coat as directed by the Engineer.

B. Additional Corrective Work: After completion of the corrective work, if the Engineer finds it is still not satisfactory, the Contractor shall perform additional corrective work on areas still not meeting the above tolerances.

C. Expense: All corrective work, including furnishing of materials, shall be performed at the Contractor's expense and no adjustment in contract time will be made for corrective action work.

D. Localized Surface Irregularities: Where surface irregularities are localized or where the Engineer determines corrective work would not be in the Owner's best interests, the Engineer may deduct from payment due the Contractor amounts equivalent to the Engineer's estimate of work costs had the corrective work been done.

3.16 STRUCTURE ADJUSTMENT

A. Prior to placement of wearing course, locate and adjust to finished pavement grade all catch basins and other structures and appurtenances within the pavement area.

3.17 PAVEMENT STRIPING

A. All areas to be marked shall be cleaned to insure proper bonding. Cleaning shall consist of flushing and sweeping plus a detergent cleaning of oil spills. Sweeping shall be completed no more than eight (8) hours prior to application of markings.

3.18 CLEANING

A. Trim and remove excess asphalt concrete accumulations from abutting structures such as curbs, manholes, catch basins, and other structure.

B. Including work of other sections, clean, repair and touch-up, or replace when directed, products which have been soiled, discolored, or damaged by work of this section. Remove excess spilled material and debris from project site upon work completion or sooner, if directed.

C. Upon completion of the work of this section promptly remove from the working area all scraps, debris, and surplus material.

3.19 PROTECTION

A. In addition to other required provisions for traffic, the following shall apply to pavement construction: No traffic or equipment shall come in contact with the compacted mixture until it has cooled and set sufficiently to prevent marking; edges shall be protected from being broken down; and edge drop-off(s) one inch or more in height shall be marked with approved reflectorized and/or flashing warning devices visible by day and night to the traveling public, and placed at spacings as specified by the Engineer.

B. Protect all work installed under this section.

C. Replace at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. On-site private concrete curb, gutter, walks, and pavement improvements.

1.3 RELATED SECTIONS
   A. Section 03 30 00 - Cast-In-Place Concrete
   B. Section 31 20 00 - Earth Moving

1.4 DESIGN AND ENGINEERING
   A. Formwork design and engineering, as well as construction, are the sole responsibility of the Contractor.

1.5 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Quality Control:
      1. Submit joint layout drawings for Engineer's and Landscape Architect's review and acceptance.
   C. Field Quality Control Submittals:
      1. Before starting work and in accordance with Section 01 33 00, prepare mockups for Engineer's review and acceptance of concrete walk surface texture.
         b. Re-prepare, if directed, until accepted.
         c. Accepted mockup represents minimum quality standard. Work of lesser quality will be subject to rejection and replacement.
      2. Accepted mockup, in like new condition, may be used in contract work.
   D. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
      1. Provide record documents.

1.6 WEATHER PRECAUTIONS
   A. Provide cold weather and/or hot weather protection as recommended in ACI 306 and ACI 305.
   B. Unless adequate protection is provided, concrete shall not be placed during rain, sleet, or snow. Protect concrete from rain water, maintain concrete water ratio and protect concrete surface.
   C. All concrete shall be adequately protected after pouring to prevent damage from freezing, by the use of suitable cover. Frozen and damaged concrete must be removed and replaced at the Contractor's expense. Do not place concrete on frozen earth.

1.7 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
CONCRETE CURBS, GUTTER, WALKS, AND PAVEMENTS

B. Installers Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

C. Product/Material Qualifications:
   1. Design data: Compaction testing shall be in accordance with Section 01 45 00, QUALITY CONTROL.
   2. Test reports: Provide job mix test reports.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.9 ADVANCE NOTICES

A. Notify Engineer at least 48 hours before intended concrete placement.

B. Place no concrete until formwork and reinforcement have been inspected.

1.10 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 CRUSHED ROCK PAVEMENT BASE

A. Imported, clean, 3/4"-0 Crushed Rock Pavement Base as specified in Section 31 20 00, EARTH MOVING.

2.2 CAST-IN-PLACE CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a minimum compressive strength of 4,000 psi at 28 days.

B. Use special mix design at accent paving per Section 03 30 00.

2.3 FORMS

A. Conform to Section 03 30 00.

2.4 REINFORCEMENT

A. Conform to Section 03 30 00.

B. Provide where shown on drawings.

2.5 CURING COMPOUND

A. Curing compound for all other concrete shall conform to AASHTO M171, White Polyethylene Film for curing concrete or AASHTO M148, Liquid Membrane-Forming Compounds for Curing Concrete.

2.6 JOINT SEALANT

A. Concrete Pavement Joint Sealant:
   1. One part polyurethane, moisture cured, non-sag elastomeric sealant meeting federal specification TT-S-00230C, Type II, Class A; ASTM C-920, Type S, Grade NS, Clas 35.
CONCRETE CURBS, GUTTER, WALKS, AND PAVEMENTS

2.7 EXPANSION JOINT FILLER
   A. Expansion Joint Filler shall be asphalt-impregnated Cane Fiber per ASTM D1751 (latest revision); 3/8" thickness unless otherwise indicated. Depth as required to extend through full slab depth and to position filler top 1/2 inch below slab top as shown on drawings.

2.8 FORMS
   A. Conform to Section 03 30 00.

2.9 TACTILE WARNINGS
   A. Shall be Stepstone, Inc., aligned truncated dome pavers 12"x12"x2". Color shall be French Gray 504.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS
   A. Prior to starting work of this section verify that existing grades and field conditions agree with drawings. Notify Engineer of deviations.
   B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.
   C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 EXCAVATION
   A. All excavation shall be in accordance with Section 31 20 00, EARTH MOVING.

3.3 CRUSHED ROCK BASE
   A. After the subgrade is compacted and at the proper grade, spread required thickness of 3/4-inch minus crushed rock. Compact by rolling or other approved method. Surface of the compacted base shall be at the proper level to receive the concrete. Manholes, catch basins, inlets, and other such structures shall be completed, adjusted, cured, and otherwise prepared, as applicable, and made clean and ready to have concrete placed in contact with them.

3.4 FORMWORK
   A. Conform to the requirements of Section 03 30 00. Construct forms to the shape, lines, grades, and dimensions called for on the Drawings. Stake wood or steel forms securely in place, true to line and grade. Brace forms to prevent change of shape of movement in any direction resulting from the weight of the concrete during placement.
   B. Allowable Tolerances: Tops of forms shall not depart from grade line more than 1/8-inch when checked with 10-foot straightedge. Alignment of straight sections shall not vary more than 1/8-inch in 10 feet.

3.5 REINFORCEMENT
   A. Reinforcement shall conform to the requirements of Section 03 30 00. Provision shall be made for placing dowels, tie bars, and other devices called for by the Contract Documents, during placement of the pavement. Reinforcement shall be placed on supporting devices, or "chairs," and maintained in position while the pavement is being placed.
3.6 FINISHING

A. After the pavement has been struck off and consolidated, it shall be scraped with a straightedge equipped with a handle to permit operation from the edge of the pavement. Any excess water shall be removed from the surface of the pavement. Irregularities shall be corrected by adding or removing concrete. All disturbed places shall be again straightedged.

B. After the concrete has been given a preliminary finish, the surface of the pavement shall be checked by the contractor with a straightedge device. Each successive check with the straightedge device shall lap the previous check path by at least half the length of the straightedge. Surface deviations exceeding 0.01 foot shall be corrected. Upon completion of the surface floating, but before any required edge tooling or joint tooling, and before initial set of the surface pavement, the pavement shall be given a textured finish perpendicular to match the existing. The textured finish shall be accomplished by a steel tine tool that will mark the finished pavement to a depth of 1/8 inch plus or minus 1/16 of an inch. Match finish of existing pavement where new pavement is adjacent. The surface of the pavement shall not vary from a true surface, when tested with a 12 foot testing straightedge, more than 1/8 inch in 12 feet.

C. Finish Types:
1. Unless Otherwise Noted: Light broom finish for slip resistant surface. Broom pattern to be parallel to slope.
2. At Accent Paving: Hard trowel with light sand blast finish.

3.7 JOINTS

A. General:
1. Construction joints, expansion joints, transverse contraction joints, and all longitudinal contraction joints shall be placed as indicated in the drawings.
2. Joints shall be aligned with adjacent utility structures, as shown on the Drawings. Field verify dimensions of utility structures prior to placement of concrete. Coordinate with affected trades. Submit RFI to engineer if discrepancy between utility structures and joints is apparent prior to concrete pour. Misalignment of joints will be corrected by removal and replacement of concrete panels and/or utility structures at the contractor’s expense.

B. Contraction Joints:
1. Longitudinal contraction joints shall consist of planes of weakness created by forming grooves in the surface of the pavement. Curb, gutter, and walk joints shall be formed.
2. Joint spacing and layout shall conform to the drawings.

C. Construction Joints: Construction joints shall be placed whenever the placing of concrete is suspended for more than 45 minutes. A butt joint with dowels or a thickened-edge joint shall be used if the joint occurs at the location of a contraction joint.

3.8 SEALING JOINTS

A. Seal joints for pavements as follows: Tool sealant reservoir for pavement joints per the details shown on the construction drawings. Clean reservoir, prepare joints, install backer rod and sealant all in strict accordance with the recommendations in the joint sealant manufacturer’s installation or application guide and in accordance with the appendix to ASTM D5893 (latest revision) (if using silicone sealant).

B. Joints to be sealed shall be filled with joint-sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible.

C. Each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and joint faces shall be clean and surface-dry when seal is applied.
CONCRETE CURBS, GUTTER, WALKS, AND PAVEMENTS

3.9 WALK EDGING
A. Before final finishing is completed and before final concrete set has occurred, finish concrete edges with edging tool shaped with 1/4 inch radius.
   1. Take particular care to maintain surface on both sides of joint in same plane.
   2. Do not use kneeling planks on concrete surface.

3.10 CURING
A. Minimum Curing Period: 3 days.
B. Uniformly apply compound in accordance with manufacturer's instructions, after final Concrete finishing is complete, and after all free water has disappeared from pavement surface.
C. Apply to concrete edges immediately after formwork removal.
D. Do not use membrane compound method if pavement will be exposed to de-icing chemicals within 30 days following curing period completion.

3.11 FIELD QUALITY CONTROL
A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.
B. Field Tests:
   1. Observance and approval of subgrade and base rock compaction.
   2. Concrete cylinder strength tests.
   3. Slump and air tests.
C. Field Inspections: Notify Engineer prior to work of this section.
D. Special Inspections for Code Compliance: Obtain building inspector approvals.

3.12 DEFECTIVE WORK
A. Remove and replace any surfaces which show excessive cracks, pavements that do not drain properly, and other defective concrete.
B. Minimum Surface Evenness: 1/8 inch per 10 ft.

3.13 CLEANING
A. Including work of other trades, clean, repair and touch-up, or replace when directed products which have been soiled, discolored, or damaged by work of this section.
B. Upon completion of the work of this section, promptly remove from the working area all scraps, debris, and surplus material.

3.14 PROTECTING COMPLETED WORK
A. Protect all work installed under this section.
B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Truncated dome tactile warning surfacing for curb ramps and other locations where traffic hazard changes, including but not limited to crosswalks, and handicapped parking travel zones.

1.02 RELATED REQUIREMENTS
A. Section 32 12 16 - Asphalt Paving.
B. Section 32 13 13 - Concrete Paving.

1.03 PRICE AND PAYMENT PROCEDURES
A. See Section 01 21 00 - Allowances, for cash allowances affecting this section.
B. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
C. See Section 01 23 00 - Alternates, for product alternates affecting this section.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS
A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MATERIALS
A. Concrete Cast-in-Place Embedment Applications:
      b. Size: 36 x 48 inches.
      c. Color: Yellow
   2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Surface Applications:
      b. Size: 36 x 48 inches.
      c. Color: Yellow
   2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION
A. Do not begin installation until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
3.02 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

B. For embedded application into concrete set tiles in correct location with edges flush with surface of finished concrete.

C. For surface applications clean surfaces thoroughly prior to installation.
   1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
   2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement, by scraping, wire brushing, sandblasting, mechanical abrasion, or approved chemicals.
   3. Sandblasting: Use equipment of size and capacity necessary, providing not less than 150 cfm of air at pressure not less than 90 psi at each nozzle used.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac.

3.03 INSTALLATION

A. Begin installation marking as soon as practicable after surface has been prepared.

B. Do not apply product during times of extreme temperature conditions or as recommended by manufacturer.

C. Apply in accordance with manufacturer’s instructions using an experienced technician that is thoroughly familiar with equipment, materials, and layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Installation and remodel of an electric solenoid controlled underground sprinkler system of PVC pipe and fittings with pop-up heads.
B. Installation of Irrigation Control Assembly and control wires, at new and existing shrub and lawn zones.
C. Installation of Central Control system, control wires, shrub and lawn zones.

1.2 RELATED REQUIREMENTS
A. Section 01 56 39 - Temporary Tree and Plant Protection
B. Section 01 60 00 - Product Requirements
C. Section 01 78 00 - Closeout Submittals
D. Division 26 - Electrical
E. Section 32 90 00 - Planting

1.3 REFERENCE STANDARDS
B. ASTM D1785: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

1.4 PROTECTION
A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave area in similar condition as found.
B. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities at Contractor's expense.
C. Use means necessary to protect materials of this Section before, during, and after installation and to protect installed Work and materials of other trades. In the event of damage immediately make repairs and replacements as directed by Owner's Representative.

1.5 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate the work with other trades affecting and affected by Work of this Section.
B. Preinstallation Meeting: Convene one week (minimum) prior to commencing work of this Section to coordinate utility marking procedures.

1.6 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturer's printed data covering products and installation instructions.
C. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with irrigation work, description of irrigation system, and Owner's contact information.
D. Record Documents: Record actual locations of installed irrigation components on a clean set of plans. Use white out and red ink to legibly re-draft as-built information.
1. Produce and keep current throughout the project.

2. Indicate two dimensions for valves, stub outs, and main line T's, L's, ends, elbow's, and change in direction.

3. Submit to Owner's Representative for approval.

E. Operation and Maintenance Data:

1. Provide written instructions at System Demonstration for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's parts catalog.

2. Submit chart showing actual precipitation rates for each zone.

3. Prepare a program for the irrigation controller for Spring/Summer; Summer; Summer/Fall using historical weather data and averages. Include start times, watering duration, day of week, repeat cycle mode, program mode, precipitation rates in inches per hour, and application quantities. Coordinate operation and programming with Owner's Representative.

F. Maintenance Materials: Provide the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements, for additional provisions.


3. Extra Valve Box Keys: One.

4. Wrenches: One for each type head core and for removing and installing each type head.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing Work of this Section who has successfully completed a minimum of 5 comparable scale projects and have the following licenses:

1. For Irrigation Work:
   a. Valid Oregon Landscape Contractors license.
   b. Valid Oregon Landscape Business license.

2. For Plumbing Work:
   a. Valid Oregon Plumbing license.
   b. Valid Oregon Landscape Contractor license.

3. Successfully completed at least 5 comparable scale projects.
   a. Submit names, addresses, dates, owners and locations of previous projects if requested by Owner's Representative.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in original unopened packaging with legible manufacturer's identification.

B. Comply with manufacturer's recommendations for storage and protection.

1. Store in a cool, dry place out of direct sunlight.

2. Protect from damage by the elements and construction procedures.

3. Store plastic pipe on firm, level supports.

4. Store plastic pipe cement in cool location.

1.9 ENVIRONMENTAL CONDITIONS

A. Temperature of mating surfaces of plastic pipe and fittings to be between 40 degrees fahrenheit and 100 degrees fahrenheit. Perform no PVC Solvent welding in rainy weather except under cover.

1.10 REVIEWS

A. Request the following reviews by the Owner's Representative two days (min.) in advance:

1. Irrigation Head Layout Review

2. Pressure Test and Mainline Installation

3. System Review

4. System Demonstration to Owner
B. Coordinate Reviews to coincide with regular progress meetings where possible.

1.11 MAINTENANCE
A. During period between system installation and Final Acceptance provide maintenance to assure proper operation of the irrigation system.

1.12 WARRANTY
A. Warranty period shall be one year following Final Completion or one full operating season following Final Completion, whichever is longer.
B. Contractor guarantees materials furnished under this Contract will be as specified and the Work will be free of defects in compliance with the Contract Documents.
C. Irrigation system must be in proper working condition at the end of the warranty period. At no additional cost to the Owner replace Work of this Section as necessary to restore system to proper working condition following the Contract Documents.
D. Visit and inspect Work at least once a month during warranty period and notify Owner's Representative in writing of any observed conditions requiring attention. Failure to provide such notification renders deficiencies the Contractor's responsibility to rectify.
E. Contractor is not responsible for loss or damage to Work of this Section caused by unusually extreme weather, vandalism, or lack of Owner’s maintenance during warranty period.

PART 2 PRODUCTS

2.1 IRRIGATION SYSTEM MATERIALS
A. Use only new materials of brands and types shown on Drawings or specified herein.
B. Similar materials must be products of one manufacturer unless otherwise approved.
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PIPE MATERIALS
A. Mainline Pipe: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.
B. Lateral Line Pipe: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.
C. Risers: One piece schedule 80 gray PVC Pipe, Type 1, threaded at both ends conforming to ASTM D1784 and ASTM D2464. No snap-risers.
D. Fittings: Polyvinyl chloride type 1, white schedule 40 and gray schedule 80; ASTM D1784, ASTM D2466, or ASTM D2464, as applicable.
E. Irrigation Sleeves: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.
F. Swing Joint Assembly Pipe and Fittings: Double swing joint risers as detailed. Swing-Pipe, snap, and “Funny pipe” risers not acceptable.
G. Flex Riser Assembly: 18 inch minimum, 3 feet maximum Swing-Pipe with transfer barb 90 degree ells at both ends and a marlex ell below the irrigation head.
H. Electrical Conduit and Fittings:
I. PVC Solvent Cement: NSF approved solvent for Class 1245-B&C PVC through 4 inches conforming to ASTM D 2564 for PVC pipe and fittings. Ensure that manufacturer's expiration date is not exceeded.
   1. At main lines: IPS Corporation Weld-On #705 PVC.
   2. At lateral lines: IPS Corporation Weld-On #705 PVC or #721 PVC.
J. PVC Cleaner and Primer: Oatey Lo-V.O.C. Purple Primer #31903.
2.3 VALVES

A. Isolation Valves - 3 inch and under: Threaded gate valve with resilient wedge sized to match mainline with wheel handle.
   1. Approved Products:
      a. Kennedy model 8057, or approved.

B. Isolation Valves - over 3 inches: Flanged gate valve with resilient wedge sized to match mainline with wheel handle.
   1. Approved Products:
      a. Kennedy model 8561, or approved.

C. Control Valve Assembly:
   1. Automatic Control Valve: Globe type, 200 psi rated, threaded connections with cross type operating handle designed to receive operating key. Size according to Valve Schedule on Drawing.
      a. For Irrigation Zones less than 5 GPM:
         1) Irritrol Model 700-1, or approved.
         2) Include Irritrol Omnireg Pressure Regulator Model OMR-100 (pressure regulating system).
      b. For Irrigation Zones larger than 5 GPM:
         1) Toro P-220 Series, or approved.
         2) Include EZ Reg (pressure regulating system).

D. Quick Coupling Valves:
   1. Approved Products:
      a. Rain Bird 44 RC.

E. Master Valve: 24V AC, normally open and flanged at both ends.
   1. Approved Products:
      a. Size: 2 inch.
      b. Model 410 by Bermad Manufacture.

F. Flow Sensor: PVC tee type sensor.
   1. Approved Products:
   2. Approved Products:
      a. Model TFS-200 by Toro.
   3. Approved Products:

G. Manual Drain Valve: Globe or angle brass manual valve with non-floating seat disk that allows positive drainage.
   1. Approved Products:
      a. Manufactured by Champion.

H. Backflow Preventers: Double check valve assembly.
   1. Approved Products:
      a. Size: 2 inch.
      b. Model # DC4A-118-T2 by Apollo.

2.4 VALVE BOXES

A. Valve box of suitable size with tee top type lid.
   1. Green box and lid.

B. Install valves in the following valve boxes:
   1. Control Valve Assembly: (2) Carson 1419-12, T-Lid.
   2. Quick Coupling Valves: Carson 910-10, T-Lid.
   6. Other Valves: Sized as applicable by Carson.
IRRIGATION

2.5 IRRIGATION HEADS
A. Makes and models shown on Drawings, or approved.

2.6 WIRE
A. Zone Control Wire: Install according to manufacturer’s wire schedule for valve specifications. 14 gauge minimum, type AVG-UF, bearing U.S. approval.
B. Communication Wire: Install according to manufacturer’s central control requirements. Wire from controller to flow sensor must be a single, unspliced length.
   1. 14 guage, PE 39 cable, 6 pair.
   2. Sentinel.
C. Wire Connections: Direct bury splice Kit.
   1. DBR/Y by 3M.
   2. Scotch Lok 3570.
D. Utility Locate Wire: 14 gauge minimum, type AVG-UF, bearing U.S. approval, blue in color.

2.7 IRRIGATION CONTROLLER
A. Pedestal mount control assembly in metal cabinet.
   1. Manufacturer: Toro Sentinel, 48 Stations.
   2. Enclosure: Stainless steel, pedestal.
   3. Model number:

2.8 RETRO LINK ASSEMBLY (FOR RAINBIRD CONTROLLERS)
A. Two (2) each Toro RLS-RB Sentinel Retro - Link Assembly. Deliver to Owner.

2.9 BACKFILL MATERIALS
A. Pea Gravel: 3/4 x 1/2 inch washed round rock.
B. Sand: Clean, fill sand free of clay, rocks, organic matter, or other deleterious material.
C. Topsoil or Loam: See Section 32 90 00 - Planting.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that required utilities and sleeves are available, in proper location, and ready for use. Verify location, type, size, psi, and GPM of existing water lines, meters, and sleeves.
B. Verify that surfaces and structures to receive Work are accurately sized and located, sound, secure, true, complete, and otherwise properly prepared.
C. Verify electrical service and conduit for Irrigation Controller is properly sized and located.

3.2 PREPARATION
A. System layout is diagrammatic. Route piping to avoid plants, ground cover, and structures. If field measurements differ slightly from Drawings modify work for accurate fit. If measurements differ substantially notify Owner’s Representative prior to installation.
B. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system and piping to minimize conflict with other work.
C. Coordinate connections to existing irrigation system, including system shut down, new connections, system re-start, and scheduling of new irrigation zone run times with Owner’s Representative.
D. Irrigation Head Layout Review: Install flags at locations of irrigation heads and components shown on Drawings. Obtain Owner’s Representative’s approval and make adjustments to locations as directed. Coordinate marking of pipe trenches and location of valves prior to executing Work.
3.3 **CUTTING OF PAVEMENT AND REPAIR**
   A. Do no cutting of pavement for installation of Work without Owner Representative’s approval.

3.4 **BACKFLOW PREVENTION DEVICE INSTALLATION**
   A. Install where shown on Drawings. Follow applicable codes and in accordance with manufacturer’s directions when making supply and central control component connections. Coordinate with other trades.
   B. Coordinate connection with other trades.

3.5 **MASTER VALVE AND FLOW SENSOR INSTALLATION**
   A. Install where shown on Drawings in accordance with manufacturer’s directions when making supply and central control component connections.

3.6 **TRENCHED**
   A. Excavate trenches with uniform bottom and remove rocks and sharp objects to provide firm, even, clean base for pipe. Width of trench to be 1.5 times the outside diameter of the pipe.
   B. Trench Depth:
      1. Minimum Cover over Installed Mainline Piping: 18 inches.
      2. Minimum Cover over Installed Lateral Line Piping: 12 inches.
      4. Minimum Cover over Installed Sleeves at other paving: 6 inches from bottom of paving.
   C. More than one pipe is permitted in the same trench provided that:
      1. Two pipes may be stacked vertically if 4 inches of Sand separates them.
      2. Three or more pipes must be laid 4 inches apart horizontally.
   D. Where excavation is performed to excess levels backfill with Sand to proper levels.
   E. Keep trenches dry and frost free. Provide and operate pumping equipment to keep excavations free from standing water.
   F. Protect existing vegetation to remain. Cut no roots over two inches in diameter without approval of Owner’s Representative. Make cuts clean, straight, at right angles to roots. Paint cuts over 1-1/2 inches diameter with approved tree paint. Repair or replace damaged plant material.

3.7 **SLEEVE INSTALLATION**
   A. Sleeves may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fills where there is potential for damage to pipes.
   B. Extend sleeves 12 inches beyond pavement edge or curb.
   C. Install level and perpendicular to sidewalks and pavement unless shown otherwise on drawings.
   D. Provide markers where sleeve ends are concealed.

3.8 **PIPE BEDDING**
   A. Mainline: Provide uniform bearing surface of Sand, 4 inches minimum depth, free of rocks and sharp objects under entire length of pipe.
   B. Lateral Line: Provide uniform bearing surface of clean topsoil, loam, or Sand. If rock or other deleterious materials are encountered bed pipe with 4 inches of Sand on all sides.

3.9 **PIPE INSTALLATION**
   A. Irrigation lines may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fill or where there is potential damage to pipes.
   B. Install pipe in accordance with manufacturer’s instructions and with the following minimum clearances around pipe:
1. 2 inch diameter and smaller: 2 inches
2. 2-1/2 inch diameter and larger: 4 inches
3. Between irrigation and other utilities: 1 foot

C. Threaded Plastic Pipe Installation:
   1. Do not use solvent cement on joints.
   2. Wrap threaded joints with teflon tape. Minimum 4 wraps of tape.

D. Cemented Plastic Pipe Installation:
   1. Cut ends square using approved pipe cutter and bevel cuts with deburring tool.
   2. Clean pipe of scale, sand, dirt, etc. prior to assembling.
   3. Avoid using an excess amount of primer and cement when making joints; particularly
      on the inside of female pipe ends and fittings.
   4. Wipe off excess cement continuously as it appears on the surface of the pipe after
      making joints.
   5. Allow fifteen minutes of cure time on joints before moving or handling. Assemble pipe
      before lowering into trench.
   6. Snake lines to allow for contraction.
   7. Transition pipe sizes at fittings and not bell end of pipes.
   8. Install thrust blocks at 90 degree corners and tees.

3.10 DRIP LINE PIPE INSTALLATION
A. Drip Line Pipe:
   1. Snake tubing to allow for expansion and contraction.
   2. Install Drip line Stakes at manufacturer's recommended spacing. Adjust spacing as
      necessary for soil conditions. Maximum stake spacing is 6 feet on center.
   3. Cut ends square using approved cutter.
   4. Clean of drip line of scale, dirt, etc. prior to assembling.
   5. Insert pipe ends to full depth of fitting.

B. PVC Manifold:
   1. Follow installation procedures for cemented plastic pipe for PVC to PVC connections.
   2. Install LOC Adapters at each PVC Manifold to align with drip line shown on drawings.
   3. Follow manufacturer's recommendations for connections to PVD to LOC Adapters and
      for LOC Adapter to Drip line.

3.11 THRUST BLOCK INSTALLATION
A. Install 2500psi thrust block at pipe corners, tees, ells, and stub outs.
   1. Pipe 2 - 3 inches in diameter: 1 cubic foot.
   2. Pipe larger than 3 inches in diameter: 2 cubic feet.

3.12 VALVE INSTALLATION
A. Install plumb and square, as detailed, and according to manufacturer's specifications.
B. Manual Drain Valves:
   1. Install at mainline low points and at outlet of control valves where laterals run uphill.
   2. Record locations on as-built drawings.

C. Install 1 valve in each valve box assembly.
D. Valve Sump: Install a minimum of 2 cubic feet of Pea Gravel below each valve. Allow for 4
   inches clearance between bottom of valve and valve sump.

3.13 VALVE BOX INSTALLATION
A. Install plumb and square with adjacent construction with one valve in each valve box
   assembly.
B. At Control Valve Assemblies bolt two valve boxes together as detailed.
C. Permanently label valve type and zone number on inside of valve box lid.
D. Set top of valve boxes flush with lawn or mulch at plant beds unless otherwise noted.
E. Provide 12 square inches (min.) of support on each side of valve box as detailed.

3.14 CONTROL WIRE INSTALLATION

A. Install wires below irrigation mainline with multiple wires bundled together at 5 foot maximum intervals in a continuous run. Use coded and labeled wires for each valve. Notify Owner's Representative for approval prior if splices are required and locate in valve box.

B. Provide 48 inches loop in wires at each valve where controls are connected and at 100 foot maximum intervals between. Coil wire around 1/2 inch rebar dowel inside of valve box.

C. Make electrical joints waterproof using specified connectors. Enclose joints in valve boxes.

D. Install wire in continuous runs with no splices unless approved.

E. Show wire routes and approved splice locations on As-Built drawings.

F. Install wires above grade or independent of the mainline in conduit.

3.15 CENTRAL CONTROL COMMUNICATION WIRE INSTALLATION

A. Install continuous run of communication wire from Master Valve to Irrigation Controller. Follow same installation procedures as Control Wire Installation. No splicing of wire is permitted.

B. Install (2) yellow Control Wires from controller to master valve in a single, unspliced length.

3.16 CONTROLLER INSTALLATION

A. Install controller in accordance with manufacturer’s specifications and applicable codes. Connect to 120V power supply at location shown on drawings and approved by Owner's Representative.

3.17 IRRIGATION CONTROL ASSEMBLY INSTALLATION

A. Install Irrigation Control Assembly in accordance with manufacturer’s specifications and applicable codes. Connect to 120V power supply at location shown on drawings and by Owner's Representative.

3.18 MAINLINE PRESSURE TEST AND INSPECTION

A. Field inspection and testing will be performed under provisions of Section 01 40 00.

B. Prior to backfilling and installing valves test irrigation mainline for leakage. Establish and maintain 100 psi pressure for 24 hours. Perform test a minimum of 24 hours after set-up of solvent weld. Notify Owner's Representative a minimum of 24 hours for review of pressure gauge at beginning and end of test period. Mainline will be accepted if pressure loss is less than 2 psi.

C. Following the pressure test but prior to backfilling, notify Owner's Representative for review of pipe, fittings, joints, thrust blocks, bedding, control wire installation, valves, and other materials for installation and water tightness.

D. After successful pressure test and mainline inspection begin backfilling and assembly of zones and system components.

3.19 BACKFILLING

A. Remove debris, sharp rocks, and decayable matter from areas to be back filled before proceeding.

B. Main Lines: Provide 6 inch Sand cover over piping then place Utility Locate Wire the entire length of pipes where control wires are not present. Backfill remainder of trench with Topsoil or Loam.

C. Lateral Lines: Backfill trench with Topsoil or Loam. Protect piping from displacement.

D. At Paved Areas: Backfill trench with Sand under paved areas.

E. Compact backfill in 6 inch lifts to match density of surrounding material. Install backfill to match adjacent elevations.
3.20 FLUSHING
A. Mainline: Open valves and thoroughly flush piping system under full water head after piping, risers, and valves are installed. Maintain flushing for three minutes. Close valves and cap risers immediately after flushing.
B. Second Flushing: Flush a second time after installation of lateral lines and sprinklers prior to nozzle installation. Flush under full water head for three minutes. Install nozzles after flushing.
C. Drip Line Flushing: Remove flush cap and flush each zone under full water head after all connections have been made. Maintain flushing for three minutes and immediately replace flush cap.

3.21 SPRINKLER HEAD INSTALLATION
A. Install plumb with top of Topsoil/Loam or Mulch as detailed and at locations shown on drawings. Allow a maximum of 3 inches clearance between sprinkler head and adjacent lawn or planting edge.
B. Install 1 cubic foot Pea Gravel sump on all low irrigation heads where drainage occurs at zone shutdown.

3.22 IRRIGATION AUDIT
A. Coordinate Work with an independent Irrigation Auditor retained by the Facilities Services Project Manager. The following results will be provided to the Contractor performing Work of this Section in a signed report by a certified irrigation auditor in good standing with the Irrigation Association (IA) and in accordance with the IA's Landscape Irrigation Auditor's Handbook.
1. Distribution uniformity for zones
2. Precipitation rates for zones
3. Catch can test of each zone with a drawing showing catch can locations
4. Flow rates, static, and dynamic pressures at each zone
5. Sentinel data summary spreadsheet.
B. Coordinate scheduling of irrigation audit at plant beds with the Owner to occur prior to plant material installation.
C. Provide Irrigation Auditor with marked up drawings, drawn at the original scale of the irrigation plan, showing as-built conditions including:
1. station numbers and locations
2. sprinkler locations and type
3. nozzle type and size
D. Adjust head types, spacing, nozzles, etc. at irrigation zones to achieve a minimum distribution uniformity of:
1. 60% at fixed spray zones
2. 70% at rotary zones

3.23 SYSTEM REVIEW
A. Prepare and start system in accordance with manufacturer's instructions. Prior to notifying Owner's Representative for review of the system review zones and make adjustments to ensure full and even coverage.
B. Notify Owner's Representative for review of system operation to determine if water afforded to all areas is complete, adequate, and uniform.
C. Adjust system for full water coverage as directed.

3.24 SYSTEM DEMONSTRATION TO OWNER
A. Instruct Owner's personnel in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance data as basis for demonstration.
3.25 CLEANING

A. Remove excess excavation, backfill materials, and other left over materials from the site. Clean improvements soiled by Work of this Section.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Preparation of subsoil.
B. Soil Material placement.
C. New trees, plants, and ground cover.
D. Mulch and Fertilizer.
E. Accent Stones.
F. Maintenance.

1.2 RELATED REQUIREMENTS
A. Section 01 56 39 - Temporary Tree and Plant Protection.
B. Section 01 60 00 - Product Requirements.
C. Section 01 70 00 - Execution and Closeout Requirements.
D. Section 31 20 00 - Earth Moving.
E. Section 32 80 00 - Irrigation.

1.3 DEFINITIONS
A. Weeds: Any plant life not specified or scheduled. Includes seeds and roots.
B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.4 REFERENCE STANDARDS
D. Standard references may be obtained from publishers

1.5 PROTECTION
A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave in similar condition as found.
B. Maintain benchmarks, monuments, and other reference points. Replace if disturbed or destroyed.
C. Contact local utility companies for verification of the location of underground utilities within the project area prior to starting excavation. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities or related facilities in an approved manner at Contractor's expense.
D. Protect drainage inlets and underground drain lines from infiltration or clogging by soils and mulch during construction until Final Completion.
E. Protect materials of this Section before, during, and after installation. Protect installed work and materials of other trades. In the event of damage immediately make repairs or replacements as directed by Owner's Representative.

1.6 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
PLANTING

B. Quality Assurance Data: Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with planting work, and Owner's contact information.

C. Submit list of plant life sources within 14 calendar days of Agreement Date.
   1. Submit confirmation from supplier(s) that specified plant materials, meeting the specifications, have been secured.
   2. Include plant name, quantity, size, condition, and name of supplier.
   3. Submit certification letter from the sod supplier(s) stating the sod has been secured or contracted for delivery. Include the quantity, grass mix, and description.

D. Product Data: Submit manufacturer's printed data for products and a list of suppliers.

E. Sample: Submit a 2 quart sample of Soil Material with supplier's name and specific location of source. Approval of Soil Material by Owner's Representative is required prior to delivery to the site.

F. Invoices: Within 2 days of delivery submit invoices, load tickets, and truck measures for Soil Material, Organic Material, and Mulch. Landscape areas will not be accepted until invoices are received by Owner's Representative.

1.7 QUALITY ASSURANCE

A. Valid Oregon Landscape Contractor's license.

B. Valid Oregon Landscape Business license.

C. Herbicide applicators must have valid State of Oregon Herbicide Applicator's license.

D. Installer Qualifications: Company specializing in installing and planting the plants with 5 projects of comparable scale successfully completed.
   1. Submit names, addresses, and dates of previous projects, owners.

1.8 REVIEWS

A. Request the following reviews by the Owner's Representative a minimum of 2 days in advance:
   1. Subgrade preparation
   2. Soil Material placement
   3. Finish grading
   4. Accent stone mock-up
   5. Accent stone placement review
   6. Plant materials
   7. Plant material layout
   8. Planting mock-up
   9. Completion

B. See Part 3 - Execution for review requirements.

C. Coordinate all reviews to coincide with regular progress meetings where possible.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide one year warranty following Final Completion or one full growing season following Final Completion, whichever is later.

C. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

D. Inspection: Visit work at least once a month during warranty period. Notify Owner's Representative and Owner in writing of any observed conditions requiring attention. Failure to provide such notification renders any deficiencies the Contractor's responsibility to rectify.

E. At the end of the warranty period, as directed by Owner's Representative and at no additional cost to the Owner:
1. Replace work not surviving, in poor condition, or not exhibiting satisfactory growth.
2. Lawns must be healthy, dense, uniform, well sodded, and reasonably weed free as judged by the Owner's Representative.
3. Reset plant materials and stones which have settled or become un-set.
4. Replace plant materials which appear to be a different species or variety than specified.
5. Provide noxious weed eradication from imported Soil Material, if required and as specified herein.
6. Complete warranty work within 30 days of warranty review.

F. Contractor is not responsible for plant loss or damage to work during warranty period which is caused by unusually extreme weather, vandalism, or Owner's lack of maintenance.

PART 2 PRODUCTS

2.1 PLANTS

A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

B. General:
1. Sizes, grades, and conditions are listed on Plant List. Quantities are shown for Contractor's convenience. Contract is responsible for providing plants drawn on drawings.
2. Cold storage stock unacceptable.
3. Free of disease, decay, injury, insects, or indication of strawberry root weevil.
4. Full foliaged when in leaf.
5. Furnish balled and burlapped (B&B) stock with solid, properly wrapped and secured, natural ball. Stock 2 inch caliper and up to be transported and handled with root ball in wire basket.
6. Furnish container stock with sufficient roots to insure healthy growth but not root bound. When plant is removed from container soil must hold together and roots must be visible but not encircling.
7. Free from Weeds or strawberry root weevil.
8. Field grown trees and shrubs must have been transplanted or root pruned at least once no more than two years prior to this Contract.
9. Container stock may be substituted for Balled and Burlapped (B&B) or Bare Root (BR) stock at any time.
10. Container or B&B stock must be substituted for BR stock if installation season prohibits use of BR stock.

C. Trees shall have:
1. Single, straight, uniformly tapering trunks which are perpendicular to the ground, unless specified as multi-stemmed or otherwise on Plant List. Trees with co-dominant, damaged, crooked, or topped leaders will be rejected.
2. Healthy and vigorous overall condition.
3. Full and even branch distribution; structural scaffold branches at least 4 inches apart where they attach to the main trunk.
4. Well developed root systems. Trees with more than 2 inches of root ball soil covering root flare will be rejected.
5. Grafts near ground level.
6. Minimum/maximum branching heights above the ground unless specified otherwise on Plant List:
   a. 2 inch caliper tree: 5' - 7'
   b. 1.5 inch caliper tree: 4' - 6'
7. Conifers shall also have full, even branching to ground level and intact single leader.
8. Trees shall be free of:
PLANTING

a. Major structural defects including, but not limited to, branches with narrow angle of attachment (less than 40 degrees to the trunk), bark with major branch unions, and trees with co-dominant leaders.
b. Poor pruning practices including, but not limited to, stubbed branches and topped leader.
c. Damage to the trunk, branches, and root system including, but not limited to, bark abrasions, sun scald, and disfiguring knots.

9. Trees shall be freshly dug during the most recent favorable harvest season.

2.2 SOIL MATERIALS

A. Topsoil: On-site soil, natural, fertile, friable; free of rock, clay, subsoil, clods, lumps, plants, roots, sticks, weeds, seeds, and other deleterious material, as approved. Re-use stockpiled Topsoil as practical.

B. Soil at Plant Beds: Blended, organic soil mix composed of loam, sand, and compost.
   1. Approved Products:
      b. Frugal Planting Soil by Lane Forest Products, Eugene, Oregon.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

C. Soil at Lawns: Sandy loam material.
   1. Products: Ballfield Loam by Eugene Sand and Gravel, or approved.

2.3 SOIL AMENDMENT MATERIALS

A. Lawn Installation Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
   1. Nitrogen: 16 percent. (source of Nitrogen to be methyl-urea based)
   2. Phosphoric Acid: 16 percent.
   4. Do not use within 50 feet of water.

B. Lawn Maintenance Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
   1. Nitrogen: 25 percent. (30% Nitrogen from slow release)
   2. Phosphoric Acid: 5 percent.
   3. Soluble Potash: 10 percent.
   4. Do not use within 50 feet of water.

C. Plant Bed Maintenance Fertilizer: Uniform composition, dry, and free flowing of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:
   1. Nitrogen: 16 percent. (Source of Nitrogen to be methyl-urea based)
   2. Phosphoric Acid: 16 percent.
   4. Do not use within 50 feet of water.

D. Planting Tablets:
   1. Product: Sierra Chemical "Agriform" with 20-10-5 chemical analysis.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

E. Micorrhizal Fungi:
   1. MycroApply® All Purpose Granular by Micorrhizal Applications Inc, Grants Pass, Oregon (541-476-3985).
   2. Substitutions: See Section 01 60 00 - Product Requirements.

F. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

G. Top Dressing: Turf Start by Rexius Inc, Eugene, Oregon, or approved.
2.4 CONCRETE PAVERS
   A. 24 inch x 24 inch or 18 inch x 18 inch x 2 inch grey concrete stepping stones, by Willamette Graystone, or approved.
   B. Substitutions: See Section 01 60 00 - Product Requirements.

2.5 ACCENT STONES
   A. Basalt stones in 2 distinct sizes:
      1. Medium Stone: Length 24"-30" x Width 18"-24" x Height 12"-18".
      2. Small Stone: Length 18"-24" x 14"-18" x 10"-14".
   B. Products:
      1. Premium Landscape Stone by Mid Valley Gravel Company, Philomath, Oregon (541-929-2200).
      2. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 STONE SPLASH BLOCK AT FILTRATION PLANTERS
   A. Basalt column with minimum dimension of 18 inch diameter x 15 inches tall.
   B. Select and set aside stones at supplier's location for approval of Owner’s Representative prior to delivery to the site.
   C. Products:
      1. Bird Bath Column by Lane Forest Products, Eugene, Oregon.
      2. Substitutions: See Section 01 60 00 - Product Requirements.

2.7 GRASS SEED
   A. Certified Oregon Blue Tag Free of Weed seed with dealer's statement analysis guarantee.
   B. Current or latest season's crop labeled in conformance with State and US Department of Agriculture laws and regulations:
      1. Purity: 98% by weight
      2. Germination: 90%
   C. Products:
      1. Lawn Seed:
         a. Natural Knit by Ledeboer Seed LLC, 503-678-7333, Aurora, Oregon
      2. Substitutions: See Section 01 60 00 - Product Requirements.

2.8 LAWNSOD
   A. Three Way Perennial Rye Blend by Willamette Turf, Salem, Oregon.
   B. Substitutions: See Section 01 60 00 - Product Requirements.

2.9 MULCH MATERIALS
   A. Mulch Material at Plant Beds:
      1. Products: Quarter Coarse Fir Bark from Lane Forest Products, Eugene, Oregon, or approved.
   B. Stone Mulch at Plant Beds:
         a. Indonesian Pebbles by Lane Forest Products, or approved.
   C. Mulch at Stormwater Planters: Refer to Civil Specifications

2.10 ACCESSORIES
   A. Wrapping Materials: Burlap.
   B. Stakes: 2 x 2 inch x 8 feet wood stakes, capable of at least 2 years ground burial, stained charcoal or black.
   C. Tree Ties: Chain lock tree ties, 1 inch wide, or approved.
D. Tree Grates: Refer to Section 12 93 00 - Site Furnishings.
E. Jute Matting: Natural fiber jute mat in 4' long rolls.

2.11 HERBICIDE
A. Broad Spectrum Non-Selective: Buccaneer Plus, or approved.
B. Selective for Broadleaves: Speed Zone, Weed-B-Gone, or approved.
C. Selective for Grasses: Envoy or approved.

2.12 METAL LANDSCAPE EDGE AND STAKE
A. 3000 Series Landscape Edge by Curv-Rite, Inc., 1-800-366-2878, or approved.
   1. Size: 1/8" x 5 1/2" x 16'.

PART 3 EXECUTION

3.1 EXAMINATION
A. Prior to installation of Work of this Section, carefully inspect the work of others and verify that such work is complete to the point where this installation may properly commence.
B. Verify that materials and surfaces to receive work specified herein are accurately sized, shaped, and located; sound, secure, true, complete, and otherwise properly prepared.
C. Verify subgrades produce positive drainage and allow for placement of Soil Material, Amendments, and Mulch to specified depths.
D. Do not install Work of this Section until all unsatisfactory conditions have been corrected. Beginning Work of this Section signifies acceptance of existing conditions.

3.2 TOLERANCES
A. Perform earthwork true to lines and grades, and to prevent ponding of water, with maximum variation in elevations of +/- 1/2 inch at subgrades and +/- 1/4 inch at finish grades.
B. Compacted thickness of materials within 1/4 inch of specified thickness.

3.3 PREPARATION OF SUBGRADE
A. Prepare subsoil to eliminate uneven areas or low spots. Maintain profiles and contours.
   Make changes in grade gradual. Blend slopes into level areas.
B. Remove foreign materials, weeds and undesirable plants and their roots, stones, rock, and dirt clods. Remove contaminated subsoil.
C. Scarify subsoil to a depth of 4 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
D. Verify subgrades, whether comprised of subgrade soil or fill drain freely. Test area by flooding with Owner's Representative present. Where water does not drain freely auger a 10 inch hole, minimum 1 per 1,000 square feet, through fill material and into subsoil, or minimum 4 feet deep into subsoil to establish positive drainage.
E. Verify subgrades allow for placement of Soil Material, Amendments, and Mulch to depths specified.
F. Notify Owner's Representative for Subgrade Preparation Review prior to placing Soil Material.

3.4 PLACING SOIL MATERIAL
A. Soil Placement Schedule:
   1. At Plant Beds: 18 inches minimum depth.
   2. At Lawn Repair Areas: place Soil Material as required to blend grades and establish positive drainage.
   3. At Lawns: 12 inches inches minimum depth.
4. Place additional Soil Material as required to establish finish grades shown on drawings and to fill in depressions, blend grades, and produce positive drainage.

B. Place topsoil during dry weather and on dry unfrozen subgrade. Suspend Soil Material placement if subgrade or Soil Material become saturated.

C. Phase Soil Material placement so that equipment does not travel over Soil Material already installed.

D. Place Soil Material in a relatively dry state to depths specified at locations shown on Drawings:
   1. Remove stones, roots, grass, weeds, debris, and foreign material while spreading.
   2. Manually spread around existing trees, paving, and other structures to prevent damage.
   3. Establish levels, profiles, slopes, contours, and uniform gradients between given grade points as shown on Drawings.
   4. Eliminate uneven or low spots at lawns and plant beds.
   5. Fine grade Soil Material within specified tolerances.

E. Notify Owner's Representative for Soil Material Placement Review prior to proceeding with Work.

3.5 INITIAL WEED CONTROL

A. Inspect plant beds and lawns for the presence of weeds. If weeds are present apply broad spectrum herbicide.

B. During herbicide application ensure safety and environmental precautions are taken and best management practices are employed. Adjust procedures adjacent to waterways.

3.6 SOIL PREPARATION AND FINISH GRADING

A. Remove debris, sticks, roots, clods, stones, and soils contaminated by petroleum products at plant beds and lawns. Rake smooth, eliminate uneven areas or low spots in Soil Material, and set grades for positive drainage.

B. Scarify subgrade to a depth of 6 inches prior to placing Soil Material. Do not allow the subgrade to become compacted after scarifying.

C. At plant beds:
   1. Apply herbicide to remove weeds as described in Initial Weed Control.
   2. Notify Owner's Representative for Organic Material Placement Review prior to proceeding with tilling and planting.
   3. Rake smooth and reset finish grades eliminating uneven or low spots in plant beds and setting grades for positive drainage. Ensure grades at edges of plant beds allow for placement of Mulch Material to specified depths and as detailed.

D. At trees:
   1. Use Soil Material for backfilling trees.

E. At lawns:
   1. Apply herbicide to remove weeds as described in Initial Weed Control.
   2. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.
   3. Rototill to a minimum depth of 4 inches, except within 10 feet of existing trees and Tree Protection zones.
   4. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
   5. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
   6. Firm seed bed with a lawn roller making passes in 2 directions.

F. At lawn repair areas:
   1. Manually remove weeds as described in Initial Weed Control.
PLANTING

2. Place additional Soil Material as necessary to fill in depressions and blend grades with surrounding lawns, plant beds, and paving.
3. Set finish grades to ensure that finish grade of lawn will be flush with surrounding surfaces.
4. Establish a friable, fine textured seed bed free of bumps and depressions immediately before seeding.
5. Firm seed bed with a lawn roller making passes in 2 directions.
6. Spread Lawn Installation Fertilizer at the rate of 15 lbs per 1000 square feet. If a Terraseeding method is used for lawn installation do not apply Lawn Installation Fertilizer.

G. Notify Owner's Representative for Finish Grading Review prior to proceeding with Work.

3.7 ACCENT STONE PLACEMENT

A. Install Accent Stones where shown on Plans. Make minor adjustments to accommodate irrigation, planting, and other site elements.
B. Place Accent Stones after weirs have been installed and soil preparation and finish grading are complete, but prior to placement of river rock, plant materials, and mulch.
C. Notify Owner's Representative at least 2 days prior to commencement of Accent Stone Placement.
D. Accent Stone mock-up and stone layout review:
   1. Owner's Representative will provide on-site aesthetic direction for stone placement to establish design intent. Acceptable mock-up represents expected quality level of the remaining stone installation and may remain as part of Work.
   2. Stake locations of Large and Medium Stones, using irrigation flags of contrasting colors for each stone size.
E. Install Accent Stones in the following sequence:
   1. Medium
   2. Small
F. Nest Accent Stones into Soil Material as detailed. In general, stones should be installed based on the following, in order of importance:
   1. Horizontal rather than vertical
   2. Wider at the ground than at the top so the stone appears to grow out of the soil
   3. Flatter surface on top
G. Notify Owner's Representative for Accent Stone Placement Review.

3.8 SECOND WEED CONTROL

A. After completion of Soil Preparation and finish grading commence irrigation of all plant beds, lawns, and erosion control grass areas. If weeds are present apply broad spectrum herbicide.
B. Wait ten days minimum and inspect all plant beds and lawn areas for the presence of any additional weeds. If weeds are present, apply a second application of Herbicide to affected areas and delay planting until all weeds are dead.
C. During herbicide application ensure safety and environmental precautions are taken and best management practices are employed. Adjust procedures adjacent to waterways.

3.9 INSTALLATION OF PLANT MATERIAL

A. Plant Material Review: Notify Owner's Representative prior to the delivery of all trees and plant materials to the site but prior to installing plants. Owner's Representative will review quality of plant materials and reject plant materials not in compliance the the Plant List and Specifications. This review is preliminary. Final approval of plants materials will not be given until Completion Review.
B. Plant Material Layout Review: Layout plant material (in containers or B&B) at plantbeds for review prior to installation. Notify Owner's Representative for review of plant material layout.
prior to commencement of planting. The plant material layout review may occur concurrently with the planting mock-up review. Adjust plant materials as directed.

C. **Planting Mock-Up Review**: Notify Owner's Representative prior to commencement of planting. Install an initial 500 square feet sample of typical plantings for review. Adjust planting procedure as directed.

D. **Tree Planting**:
   1. Soak container grown, B&B, and BR plants before planting.
   2. Remove extra soil on top of root ball to expose flare of first buttress root. Root flare must be visible at top of root ball.
   3. Dig individual planting holes circular with vertical sides as shown on Planting Detail.
   4. Save and thoroughly loosen soil removed from planting hole and use as backfill around tree. Backfill trees with specified mixture if additional Soil Material is needed.
   5. Sprinkle micorrhizal fungi to surface of planting holes at rate of 2-4 ounces per inch of stem caliper.
   6. Install Planting Tablet at trees at manufacturer's recommended high rate.
   7. Lift trees by wire basket only. Do not lift trees by trunk or use trunk as a lever to position or move tree.
   8. Set B&B trees in the hole with the north marker facing north unless otherwise approved.
   9. Set root crown as shown on Planting Detail not less than 3 inches above surrounding finish grade.
   10. Cut and completely remove twine and other fasteners from root ball. Remove burlap from top half of root ball. Remove all burlap if not biodegradable. Neatly cut off broken or frayed roots.
   11. Remove top half of wire basket after planting.
   12. Stake trees as shown on Planting Detail.

E. **All other Plants**:
   1. Soak container grown, B&B, and BR plants before planting.
   2. Dig individual planting holes with circular and with vertical sides 1-1/2 inch shallower than depth of root ball.
   3. Dig holes for pocket-planted shrubs 3 times the diameter of the rootball.
   4. Sprinkle micorrhizal fungi to surface of planting holes at the following rates:
      a. #SP4 container - 1 tablespoon
      b. #1 container - 2 tablespoons
      c. #3 container - 3 tablespoons
      d. #5 container - 5 tablespoons
   5. Install Planting Tablet at shrubs and ground covers at manufacturer's recommended high rate.
   6. Cut circling roots with a sharp knife.
   7. Set root crowns 1-1/2 inch above surrounding grade and as detailed.

F. Plants set too deeply will be rejected. Reset plants that have settled.

G. Set Plants plumb and for best appearance.

H. Carefully tamp soil under and around root balls and bare roots to prevent settlement.

I. Backfill pocket-planted plants with Soil Material.

J. Flood hole when half backfilled and tamp soil between bare roots.

K. Complete backfilling and tamp soil between bare roots.

L. Thoroughly water each plant and entire bed immediately after planting.

M. Remove all tags, labels, strings, etc. from plants.

N. Prune Plant Material to remove dead, broken, or damaged branches.
O. Rake plant beds smooth, resetting finish grades for positive drainage and eliminating uneven or low spots.

3.10 METAL LANDSCAPE EDGE AND STAKE INSTALLATION
A. Install per manufacturer's recommendations.

3.11 MULCH INSTALLATION
A. Install 3 inch minimum depth Mulch within 24 hours after planting at plant beds and trees as shown on drawings and details.
B. Remove excess Mulch from foliage of plant materials and from bark of trees. Mulch must not be placed within 3 inches of tree trunks. Remove mulch from adjacent surfaces and produce edges shown on Details.

3.12 LAWN INSTALLATION
A. Install lawns using one of the following methods, except do not use sod at reinforced paving areas and Terraseeding is required at Renovated Lawns in no rototilling zones.
   1. Hydroseeding:
      a. Mix components are the following rates and apply uniformly and completely:
         1) Seed: 8 lbs per 1000 square feet
         2) Lawn Installation Fertilizer: 15 lbs per 1000 square feet
         3) Sufficient hydromulch to keep areas moist during germination and protect seed from wind erosion.
      b. Ensure all equipment, including hoses, is clean and contains only the specified seed.
   2. Terraseeding:
      a. Apply a 1 inch layer of Top Dressing injected with the following:
         1) Seed: 6 lbs per 1000 square feet or per manufacturer's specifications.
         2) Lawn Installation Fertilizer: 15 lbs per 1000 square feet.
         b. Do not install Top Dressing within mulch circles at trees.
         c. Approved Installer: Rexius Forest Byproducts, Eugene, Oregon, or approved.
   3. Sod:
      a. Apply Lawn Installation Fertilizer at a rate of 15 lbs per 1000 square feet.
      b. Dampen soil sufficiently to prevent moisture from being drawn out of sod.
      c. Protect sod from effects of severe weather conditions. Install sod within 48 hours of delivery.
      d. Lay on prepared grade butting edges tightly together.
      e. Stagger joints on adjacent courses so that end joints are at least 6 inches apart.
      f. Press sod to prepared base by rolling with a 100 lb (minimum) roller.
      g. Aerate new sod 6 weeks after installation.
B. Apply water with fine spray immediately after each area is sown.
C. Provide a temporary barrier at the limits of newly planted lawns.

3.13 TREE PRUNING
A. Perform pruning of trees as recommended in ANSI A300.
B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.14 MAINTENANCE
A. At Plant Beds during period between installation and Final Completion:
   1. Water, fertilize, weed, reset unstable or disturbed plants, and perform other maintenance necessary to assure healthy growth.
   2. Install Plant Bed Maintenance Fertilizer at a rate of 6 lbs per 1000 square feet 45-60 days after installation. Adjust timing for seasonal requirements of plant materials.
   3. Thoroughly water immediately after applying Plant Bed Maintenance Fertilizer.
   4. Repair and regrade erosion damage.
5. Provide continued weed control and removal until any weed problem is fully eradicated.

B. At lawns during period between installation and Final Completion:
   1. Water, weed, mow, reseed, top dress, and fertilize as necessary to establish a healthy, dense, uniform, weed free stand of grass; maintain at 2 inches high. This includes unirrigated lawns, unless otherwise noted on drawings.
   2. Conduct first mowing after grass is firmly rooted and secure. Mow grass when it exceeds 2 inches in height, cutting no more than 1/3 of the grass height at a time. Remove all clippings.
   3. Maintain surfaces and supply additional Soil Material and Seed where necessary.
   4. After first mowing apply Lawn Maintenance Fertilizer at a rate of 8 lbs per 1000 square feet. Thoroughly water after application.
   5. Apply Herbicide (selective) to remove weeds.

3.15 CLEANING
   A. Remove excess materials from site. Protect drain inlets and underground piping as necessary and clean improvements soiled by Work of this Section.

3.16 COMPLETION REVIEW
   A. Notify Owner's Representative for Completion Review when Work of this Section is complete.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Factory fabricated landscape trellis panel system.
B. Fasteners and accessories.

1.2 RELATED REQUIREMENTS
A. Section 32 93 00 - Plants: Soil preparation, planting and maintenance of climbing plants.

1.3 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturer's product data, standard details, details specific to this project and written installation instructions.
C. Shop Drawings: Submit elevations and plan drawings. Indicate the following:
   1. Wire size and patterns.
   2. Panel size and layout.
   3. Panel frame component dimensions and thickness.
   4. Attachment and standoff bracket details.
D. Verification Samples: For each product and finish specified provide two samples, 12 inches square minimum; show actual product, color, and patterns.
E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Landscape Trellis Panel System:
   2. Green Screen: www.greenscreen.com
B. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 LANDSCAPE TRELLIS PANEL SYSTEM
A. Modular panel system of prefinished hot dipped galvanized steel frame, trim and welded wire fabric infill for use as exterior climbing plant landscape feature; system includes fasteners, trim and hardware for fastening panels to exterior wall surfaces specified elsewhere.
   1. Panel Size: Refer to drawings.
   2. Wire: 10 gage (0.1019 inch diameter).
   3. Wire Grid: 3 inches.
   4. Truss: 3 inches deep ladder; corresponding to grid size and continuously welded to front and back grid panels.

2.3 ACCESSORIES
A. Fasteners: Manufacturer's standard stainless steel bolt, flat washer and lock washer, rust free after 300 hours when tested in accordance with ASTM B117.
B. Anchor Clips and Hold Off Brackets: Manufacturer's standard; same material and finish as frame.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verification of Conditions: Examine work area with installer present.
   1. Verify dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.
2. Do not proceed with installation until existing conditions are satisfactory.
3. Verify panel system location on site.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Anchor supports securely with allowance for thermal movement and structural support.
C. Erect panel system square, plumb, straight and accurately fitted with tight joints.
D. Do not install warped, bowed, dented, abraded, broken or otherwise defective components. Do not install components with damaged factory applied coatings.
E. Do not cut, trim, weld or braze components during erection. Return parts that require alteration to shop for refabrication or for replacement with new parts.
F. Separate dissimilar metals and use gasketed fasteners or other isolation method to prevent corrosive or electrolytic action between metals.

3.3 PROTECTION

A. Protect installed panel system from subsequent construction operations.
B. Touch-up, repair or replace damaged products.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Private on-site water distribution system improvements, including domestic system, fire distribution system.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
   A. Section 31 23 33 - Trenching and Backfill

1.4 REFERENCED SPECIFICATIONS
   A. ASTM Standards (current edition)
   B. AWWA Standards (current edition)
   C. NFPA Standards (current edition)

1.5 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer's specifications and technical data including performance, construction, and fabrication information.
      1. Submit for: None required. Pipe materials and fittings, valves, valve boxes, fire hydrants, backflow preventers, backflow preventer vaults and enclosures, and sump pump.
      2. Submit buoyancy calculations for backflow preventer vault. Use a factor of safety of 1.5 and assume groundwater level at 1 ft below finished grade as per Geotechnical Report.
      3. Contractor shall provide the Architect with 6 sets of shop drawings complying with Eugene Fire Department private water system review checklist. After Architect's review, submit three copies of shop drawings to Fire Department for review and approval. Shop drawings shall incorporate all information required by the private water system review checklist including, but not limited to, the following: pipe sizes, materials, locations, depth of bury; fire hydrant types and locations; fire department connection types and locations; indicate pipe restraint type (thrust blocking or mechanical joint restraint), size, and locations.
   C. Field Quality Control submittals as specified in Part 3 of this Section:
      1. Field Tests
      2. Special Inspections for Code Compliance
   D. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
      1. Provide record documents.

1.6 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
   B. Installer's Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.
1.7 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer's identification.

B. Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.8 ADVANCE NOTICES

A. Notify Engineer at least 48 hours before starting work of this section.

1.9 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER, FIRE PROTECTION WATER, AND FITTINGS (4 INCH AND LARGER) (UNLESS OTHERWISE NOTED)

A. Polyvinyl Chloride Plastic Pipe:
   1. Pipe: PVC, AWWA C900 (4" to 12"), AWWA C905 (14" to 16"), DR 18.
   2. Fittings: Gray or Ductile iron, mechanical joint, conforming to AWWA C110 or AWWA C153, with exterior asphaltic seal coat and cement mortar lining per AWWA C104 or Fusion Bonded Epoxy in accordance with AWWA C116.
   3. Joints:
      a. Unless otherwise specified: Gasket, push-on joints unless otherwise specified, conforming to ASTM D3139.
      b. Mechanical Joints: AWWA C110, with gasket joints per AWWA C111 and corrosion resistant bolts.

B. Restrained Joints: Provide as indicated on the drawings according to the following:
   1. Mechanical Joints: UL and FM approved, ductile iron mechanical joint follower gland with restraining wedges secured to pipe by torque limiting twist-off nuts, EBBA Iron Sales "Mega Lug" Series 2000 PV or Romac "Romagrip".

2.2 BUILDING SERVICE DOMESTIC WATER PIPE AND FITTINGS (3 INCH AND SMALLER) (UNLESS OTHERWISE NOTED)

A. Polyvinyl Chloride Plastic Pipe:
   1. Option #1:

2.3 DOMESTIC WATER, FIRE PROTECTION WATER, AND MAINLINE IRRIGATION PIPE AND FITTINGS (3 INCH AND SMALLER, BUILDING APPROVED MATERIAL)

A. Conform to Division 22.

2.4 GATE VALVES FOR DOMESTIC AND FIRE PROTECTION SYSTEMS

A. Shall be iron body, class 125, flexible wedge disc, non-rising stem, stuffing box repackable under pressure, UL listed and FM approved fire protection system only, rated working pressure of 150
psi minimum and conforming to AWWA C515-01. Crane, Kennedy, or Grinnell. Similar to Kennedy Model 7561 or Kennedy Model 7572.

2.5 CHECK VALVES (3 INCH AND LARGER)

A. Type shall be swing with renewable composition seat and iron disc. Body shall be iron or bronze with bronze trim and bolted bonnet. Class 125, rated working pressure 125 psig steam minimum; 200 psig WOG. UL listed, FM approved. Manufacturer: Crane, Grinnell, Nibco, Powell, or Hammond.

2.6 VALVE BOXES

A. Cast iron conforming to ASTM A48 (latest revision), rated for H20 traffic loading, with a rust protective coating; cover marking "water"; bury depth as required on drawings. Olympic Foundry, Inc. VB910.

2.7 FIRE HYDRANTS

A. Acceptable Manufacturers" Mueller Centurion; Kennedy K-81D; M&H #129.

B. Color: Painted Safety Yellow.

C. Construction: Dry bonnet type with internal operating nut enclosure located above the plane of the nozzles; dry barrel compression type that opens against pressure, with valve in "up" position when closed; high profile design with 30" minimum dimension from top of hydrant to the bury line at approximately 3" below the break flange.

D. Main Valve: 5-1/4"

E. Inlet Flanges: 6" with MJ style connection on the shoe, complying with EWEB standards.

F. Nozzle Section: 3-way design with two 2-1/2" NST hose nozzles and one 5-1/2" NST pumper nozzle. There shall not be any type of cap retainer chains or devices.

G. Operating Nut: one piece design with weather cap or seals with 1-1/2" pentagon, opening left.

H. Provisions for Lubrication: Provide for stem lubrication through either an oil reservoir or pressure lubrication fitting.

I. Main Valve Drain Valve: non-corrosive metal with rubber drain valve vacings.

J. Packing Glands and Seals: O-ring type.

K. Applicable Standards: AWWA C502, UL Listed and FM approved, subject to approval of fire department.

2.8 FIRE DEPARTMENT CONNECTION

A. Shall be double clapper, 2-way, 90 degree Siamese inlet; rough brass; two 2-1/2 inch inlets, one 4 inch outlet; brass caps with chains, National Standard Threads threads conforming to local fire department; UL listed, FM approved, and conforming to City standards. Designated "AUTO SPRINKLER". Contractor to verify manufacturer with Fire Marshal.

B. Provide with back outlet to facilitate installation at face of bollard per drawings.
2.9 BACKFLOW PREVENTERS

A. Fire Protection System:
   1. Backflow Preventer: Double check detector backflow preventer, 6 inch, maximum working pressure of 175 psi, with OS&Y gate valves, flanged joints, UL listed and FM approved. Febco, Apollo, or Conbraco (meeting EWEB requirements). Provide with watertight plugs or caps on test cocks. Provide without detector meter.
   2. Strainer: Wye-strainer, cast iron body, unplugged NPT blowoff connections on cover, recessed screen seats, perforated 304 stainless steel screen, Febco model 758A or approved.
   3. Tamper Switch: Provide tamper switch, UL listed as "Extinguishing System Attachment" for the location and type of valve supervised, single pole double throw contacts, connected to each OS&Y gate valve on the backflow preventer assembly, mounted to not interfere with normal valve operation, UL indoor/outdoor rated enclosure, System Sensor Model OSY2, installed per manufacturer recommendations and in accordance with Section 28 3163 [edit as needed]. Tamper switch operation shall cause a supervisory signal to be transmitted to the Fire Alarm Control Panel upon not more than two complete turns of the valve wheel or a closure of ten percent, whichever is less. Supervisory audible and visible alarms at these locations shall be distinct from either alarm or trouble conditions involving the same or related devices.

B. Domestic System:
   1. Backflow Preventer: Double check backflow preventer, 2-1/2 inch, maximum working pressure of 175 psi, with NRS gate valves, flanged joints, UL listed and FM approved. Febco, Apollo, or Conbraco (meeting EWEB requirements). Provide with watertight plugs or caps on test cocks. Provide without detector meter.
   2. Strainer: Wye-strainer, cast iron body, unplugged NPT blowoff connections on cover, recessed screen seats, perforated 304 stainless steel screen, Febco model 758A or approved.

C. Irrigation System:
   1. Backflow Preventer: Double check backflow preventer, 2 inch Irrigation, maximum working pressure of 175 psi, with full port union ball valves, UL listed and FM approved. Febco, Apollo, or Conbraco (meeting EWEB requirements). Provide with watertight plugs or caps on test cocks. Provide without detector meter.
   2. Strainer: Wye-strainer, cast copper alloy body, unplugged NPT blowoff connections on cover, recessed screen seats, perforated 304 stainless steel screen, Febco model LF650A or approved.

2.10 BACKFLOW PREVENTER VAULTS (BELOW GRADE)

A. Vault:
   1. Vault: Precast reinforced concrete vault per ASTM C-875, rated for H20 traffic loading, size appropriate to selected backflow preventer and conforming with details, joints and openings grouted watertight. Utility Vault or approved.
   2. Hatch, ladder, and BFP configuration shall conform to OSHA requirements.
   3. Ladder: Provide galvanized ladder meeting OSHA requirements and capable of extending 42 inches above top of vault. Ladder to be permanently mounted when vault depth exceeds 4 feet. 
   4. Access Hatch
      a. Fire Service: Galvanized hinged access hatch, 3’ ± by 6’ ± minimum opening size, traffic rated for H20 loading, locking latches, spring assisted doors. Access hatch shall factory-applied, ADA-approved, non-skid coating on all metal surfaces exposed to traffic.
WATER UTILITIES

b. Domestic/Irrigation Service: Aluminum hinged access hatch, 3' ± square minimum opening size, traffic rated for H20 loading, locking latches, spring assisted doors. Access hatch shall factory-applied, ADA-approved, non-skid coating on all metal surfaces exposed to traffic. Hatch shall be Bilco model J4ALH20 or approved.

B. Permanent Dewatering System - Sump Pump:
1. Sump Pump:
   a. Type: Submersible.
   b. Motor: Oil filled, built-in auto reset overloads.
   c. Bearings: Permanently lubricated.
   d. Impeller: Bronze no-clog.
   e. Seal: Mechanical
   f. Controls: Built-in, internal control system. Set "on" level at 7 to 10 inches above sump floor and one high water alarm float.
   g. Cord: 3-wire with 3-prong grounded plug, 10-foot long.
   h. Power / Power Supply: 1/3 HP, 120 volt, 1-phase.
   i. Capacity: 20 gpm at 22 ft total head
   j. Manufacturer: Hydromatic, Paco, Little Giant, or approved.
   k. Refer to Electrical for power, receptacle, and connections.
2. Discharge Piping:
   a. Routing: Route piping from sump pump discharge through vault, holding tight to sides of vault. Extend through piping through vault side to a weep hole to be drilled through the nearest curb on site as detailed on drawings.
   b. Pipe: 2" diameter PVC Schedule 40 per ASTM D1784 with solvent cement joints.
   c. Check Valve / Union: Thermoplastic industrial ball check type manufactured per ASTM F 1970, Spears True Union 2000 or approved. Locate valve 12-18 inches above pump discharge elevation or as recommended by pump manufacturer.

C. Vault High Water Alarm:
1. Float Switch: Corrosion resistant, high impact float switch with normally closed contacts, SJE Signal Master or approved. Set float switch at 18 inches above vault floor. Provide waterproof junction box mounted within vault and provide additional float switch wiring as needed to reach connection points located inside building.
2. Alarm Configuration: Connect high water alarm float switch directly to Building Automation System (BAS). No separate alarm panel required. Alarm signal to trigger "critical" alarm [in BAS to signal pump failure and alert maintenance staff.
3. Wiring and Connections: Electrical contractor to provide power and connections. All electrical work shall comply with Division 26, and shall be performed by a licensed Electrician.
4. Signs: Provide engraved plastic signs conforming to Section 260553 <edit as needed>. Location and text of sign as follows:
   a. Backflow Preventer Vault: Mount sign on inside of vault wall above float switch at a location visible from the access hatch. Sign text:
   b. HIGH WATER ALARM FLOAT SWITCH TIED TO CAMPUS B.A.S. AS POINT ___<coord name with UO>. NOTIFY CPS CONTROL ROOM PRIOR TO DISTURBING OR TESTING.

2.11 CHECK VALVE VAULT
A. Precast concrete vaults, size appropriate to selected check valve conforming with details. Utility Vault Company, or approved. Top shall be provided with diamond plate access hatch minimum size, 3' ± by 3'±, hinged access, locking latches.

2.12 BALL DRIP
A. Ball drip shall have brass body, inlet and outlet threads, and have automatic operation.
WATER UTILITIES

2.13 MECHANICAL JOINT RESTRANINT RESTRAINED JOINTS


2.14 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1 1/2 inches.

2.15 OTHER MATERIALS

A. Recommended by Manufacturer and subject to Engineer's review and acceptance. Provide all materials required to complete and make water system operational.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to installation, carefully inspect trench, excavations and base to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this Section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 TRENCHING AND BACKFILL

A. Trenching and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 PIPE INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations. All pipe ends and interiors shall be thoroughly cleaned of all foreign matter and shall be kept clean during installation. When work is not in progress, all open ends of pipe and fittings shall be securely closed so that no trench water, earth, animal life or other substance may enter.

B. Cutting of pipe to be done in a neat and workmanlike manner by method which will not damage pipe and as recommended by manufacturer.

C. Install piping within 0.02 feet of indicated grade and location.

D. All ductile iron pipe joints and fittings shall be fully covered with asphaltic coating.

3.4 THRUST BLOCKS AND MECHANICAL JOINT RESTRAINT

A. Install at all changes of directions and fittings as shown on the drawings.

B. Install mechanical joint restraint at fittings and pipe joints where indicated on drawings.
WATER UTILITIES

3.5 VALVES, FITTINGS AND CAPS
   A. Shall be set and joined to the pipe as shown on the drawings. All pipe shall be supported to prevent stress on valves. All dead ends shall be closed with plugs or caps that are suitably restrained to prevent blowing off under test pressure.

3.6 VALVE BOXES
   A. Shall be provided for every valve. Box shall be centered along axis of the operating nut of the valve and shall be set so as not to transmit shock or stress to the valve or valve operator. Keep box free of debris.
   B. Set rim flush with adjacent finished surfaces unless otherwise noted.

3.7 FIRE HYDRANTS
   A. Conform to referenced specifications AWWA Manual M17 and AWWA C600.
   B. Set fire hydrant plumb, and square with adjacent construction.

3.8 FIRE DEPARTMENT CONNECTION
   A. Conform to referenced specifications AWWA Manual M17 and AWWA C600.
   B. Install fire department connection in cast-in-place bollard as shown on the drawings.

3.9 DOUBLE CHECK BACKFLOW PREVENTER AND VAULT
   A. Install on compacted gravel base, level, plumb, square with adjacent construction, with rim flush with adjacent surfaces in accordance with manufacturers recommendations. Chain gate valves in open position with galvanized chain and padlock. Comply with EWEB installation requirements.
   B. EWEB to provide and install detector meter on backflow preventer and remote reader in vault at property line. Coordinate vault requirements with EWEB. Coordinate work and schedule with EWEB.
   C. Construct drain line from vault through adjacent curb as a weephole as indicated on drawings. Locate drain so that drain extends level from vault to daylight.
   D. Manufactured pipe supports to be installed and adjusted appropriately to support backflow preventer at the required elevations.

3.10 CHECK VALVE VAULT
   A. Install on compacted gravel base, level, plumb, square with adjacent construction, in accordance with manufacturers recommendations. Set vault rim 3/4" above surrounding grade to limit water infiltration.
   B. EWEB to provide and install detector meter on backflow preventer and remote reader in vault at property line. Coordinate vault requirements with EWEB. Coordinate work and schedule with EWEB.
   C. Construct drain line from vault to adjacent domestic/irrigation backflow preventer vault with positive slope.

3.11 CONNECTIONS TO EXISTING WATER MAINS
   A. Prepare shut-down plan and submit to UO EH&S, fire marshal, and Architect for approval.
WATER UTILITIES

B. Water mains that are to be cut into for new connections shall be repaired per Oregon DHS Drinking Water Program requirements.

C. Connections to existing mains shall be not result in shut down of water service to existing facilities for more than 6 hours <coordinate with Owner and edit as needed>. Schedule additional crews as needed to complete work within necessary time frame. Conduct work during non-peak hours as directed by Owner.

D. Preparation for Repair:
1. Turn valve down to reduce mainline flow but maintain positive pressure.
2. Excavate below the main creating a sump and dewater.
3. Isolate mainline by shutting other services off providing advance notice to all users as required. Notify Owner 48 hours prior to starting work.

E. Repair process:
1. Treat exterior of exposed pipe with hypochlorite solution (account for control of residual chlorine in discharge water).
2. Disinfect all repair items, piping and appurtenances per AWWA C651 Standard.
3. Conduct the repair with disinfected parts and ensure sump dewatering system is operational.

F. Cut-in process:
1. Initiate the cut in procedure by removing existing pipe and dewatering the remaining pipe.
2. Treat exterior of exposed pipe with hypochlorite solution (account for control of residual chlorine in discharge water).
3. Disinfect all repair items, piping and appurtenances per AWWA C651 Standard. Complete the cut in procedure with disinfected parts.

G. Finalizing connection construction:
1. Repressurize the main by opening mainline valve and check for leaks.
2. Flush the line through a fire hydrant or blowoff.
3. Flush in a direction to best clear the main of any debris/sediment and until air is gone and water flows clear.
4. For water systems that apply and maintain a chlorine residual, check the chlorine residual at a point downstream of the main break. Residual should be consistent (not lower) with surrounding area.
5. Collect a coliform bacteria sample per AWWA C651 Standard to provide a record of repair procedure effectiveness. Mark as a “special sample” and retain in records for 2 years.
6. Restore all valves to their normal operating positions.
7. Open user services and operate the outdoor hose bib to remove air and turbid water. If no outside bib is accessible, coordinate building access with Owner.
8. If the post-construction coliform sample result shows the presence of coliforms, resample per coliform sampling procedures. If second sample results show presence of coliforms, contact Architect to consult on corrective action.

3.12 WORK BY UTILITY COMPANY

A. Initiate service, coordinate, and schedule water service, connection, meter installation, detector meter, remote reader, and vault installation by EWEB.

B. Owner to pay EWEB costs directly.

3.13 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
1. Hydrostatic tests as described below.
2. Disinfection Tests.

C. Field Inspections: Notify Engineer prior to work of this section.

D. Special Inspections for Code Compliance:
   1. Test hydrostatically. All testing, acceptance, and documentation shall comply with Oregon State Plumbing Specialty Code (current edition) and NFPA and AWWA specifications as applicable.
   2. Prior to testing partially backfill or provide other means of restraint to prevent any movement during the test.
   3. Observance: Plumbing inspector to observe domestic, mainline irrigation, and fire line testing. Fire Department to observe fire line testing. Contractor shall notify plumbing inspector and Fire Department at least 48 hours prior to testing.
   4. Obtain plumbing inspector and fire marshal approvals and submit to Engineer.

3.14 FLUSHING AND DISINFECTION

A. Flushing:
   1. Contractor shall flush and clean all parts of all completed system. All pipe and structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Engineer.

B. Disinfection:
   1. Disinfect all domestic water supply piping and appurtenances in accordance with AWWA C651 and Oregon State Health Department requirements.
   2. Provide written certification from a firm specializing in disinfection that the disinfection has been successfully completed.
   3. Dispose of test water in accordance with all governing rules and regulations.

3.15 CLEANING

A. Upon completion of the work of this section promptly remove from the working area all scraps, debris and surplus material.

3.16 PROTECTION

A. Protect all Work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS

A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES

A. On-site private sanitary sewer system improvements.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS

A. Section 31 23 33 - Trenching and Backfill
B. Section 33 39 13 - Sanitary Utility Sewerage Manholes, Frames, and Covers

1.4 SUBMITTALS

A. Comply with Section 01 33 00, unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data including performance, construction, fabrication, and installation information.
   1. Submit for: None required. Pipe, fittings, and cleanout covers.

C. Field Quality Control submittals as specified in Part 3 of this Section:
   1. Field Tests
   2. Special Inspections for Code Compliance

D. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
   1. Provide record documents.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.

B. Installer's Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer's identification.

B. Storage and Protection: Comply with manufacturer's recommendations.
   1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICE

A. Notify Engineer at least 48 hours before starting work of this section.

1.8 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.
PART 2 - PRODUCTS

2.1 SANITARY SEWER PIPE AND FITTINGS (8 INCH AND LARGER)

A. Either of the following options for pipe material options may be used:
   1. Option #1:
      a. Pipe: PVC, type PSM, SDR 35, ASTM D3034 (8"-15") and ASTM F679 (18"-24")
      b. Fittings: PVC, ASTM D3034. For 90° changes in flow direction, long-sweep bends or combinations of 45° bends shall be used.
      c. Joints: Bell and spigot with rubber gaskets, conform to ASTM D3212 and ASTM F477.
   2. Option #2:
      a. Pipe: Polypropylene Pipe (12"-30"), type dual wall, ASTM F2736 (12"-30") and ASTM D2412. ADS Santite HP Sanitary Pipe or approved.
      b. Fittings: PVC DWV, ASTM F2736 and D477. For 90° changes in flow direction, long-sweep bends or combinations of 45° bends shall be used.
      c. Joints: Bell and spigot with rubber gaskets, conform to ASTM F2736.

2.2 SANITARY SEWER PIPE AND FITTINGS (6 INCH AND SMALLER)

A. Either of the following options for pipe material options may be used:
   1. Option #1:
      b. Fittings: PVC, ASTM D3034. For 90° changes in flow direction, long-sweep bends or combinations of 45° bends shall be used.
      c. Joints: Bell and spigot with rubber gaskets, conform to ASTM D3212 and ASTM F477.
   2. Option #2:
      b. Fittings: PVC DWV, ASTM D2665 and D3311. For 90° changes in flow direction, long-sweep bends or combinations of 45° bends shall be used.
   3. Option #3:
      b. Fittings: ABS DWV, ASTM D2661 and D3311.

2.3 SANITARY SEWER PIPE AND FITTINGS (BUILDING APPROVED MATERIAL, 3"-6", FOR USE UNDER AND WITHIN 5 FEET OF BUILDINGS)

A. Conform with Division 22.

2.4 CLEANOUTS

A. Shall be constructed from solid wall pipe and fittings specified above with locking traffic grade frame and cover. Frame and cover shall be H20 rated cast iron valve box as detailed on drawings with "sewer" marking. Olympic Foundry 910.

2.5 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.6 OTHER MATERIALS

A. Recommended by Manufacturer and subject to Engineer's review and acceptance. Provide all materials required to complete and make drainage system operational.
PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work of this section, carefully inspect trench, excavations, and pipe bedding to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 TRENCHING AND BACKFILL

A. Trenching and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 PIPE INSTALLATION

A. Installation shall be in accordance with the manufacturer’s recommendation. All pipe ends and interiors shall be thoroughly cleaned of all foreign matter and shall be kept clean during installation. When work is not in progress, all open ends of pipe and fittings shall be securely closed so that no water, earth, animal life, or other substance may enter.

B. Cutting pipe shall be done in a neat and workmanlike manner by method which will not damage pipe and as recommended by manufacturer.

C. Install piping within 0.02 foot of indicated grade and location.

D. Trim pipe ends flush with manhole interior walls.

E. All ductile iron pipe joints and fitting joints within 5 feet of building and beneath building shall be fully covered with asphaltic coating. Wrap ductile iron pipe and fittings within 5 feet of building and beneath building with polywrap.

3.4 CLEANOUTS

A. Construct on compacted 4" minimum depth 3/4" - 0 crushed rock base level, plumb, and square with adjacent surfaces. Set rim flush with adjacent finished surfaces unless otherwise noted.

3.5 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Hydrostatic or air test as described below.
   2. TV Inspections and Reports:
      a. Provide for all sanitary sewer pipe 8 inch diameter and larger.
   3. Deflection Test:
      a. Conduct deflection tests of flexible pipe. The testing shall be conducted by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95 percent of the pipe initial inside diameter. Conduct testing on a manhole-to-manhole basis after flushing and cleaning.
      b. The mandrel shall be pulled in front of the camera so the deflection testing is clearly recorded on the video tape unless approved by the Engineer.
SANITARY SEWERAGE UTILITIES

c. A water depth gauge shall be provided, located on the TV camera side of the mandrel. The gauge shall be graduated with marks at 0.50" increments clearly visible during TV inspection. The gauge shall be capable of measuring depth of water in 0.50" increments from 0.50" to 2.5". The gauge shall be designed so it will remain plumb regardless of the rotation of the mandrel or camera.

d. Deflection testing shall be conducted and accepted prior to any paving being done.

C. Field Inspections: Notify Engineer prior to work of this section.

D. Special Inspections for Code Compliance:
   1. Provide hydrostatic test or air test per State of Oregon Plumbing Specialty Code.
   2. Obtain plumbing inspector approvals and submit to Engineer.

3.6 CLEANING

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed system. All pipe and structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Engineer.

B. Upon completion of work of this section promptly remove from the working area all scraps, debris, and surplus material.

3.7 PROTECTION

A. Protect all work installed under this section.

B. Replace at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Manholes for on-site private sanitary sewer system improvements.

1.3 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
   A. Section 31 23 33 - Trenching and Backfill
   B. Section 33 30 00 - Sanitary Sewerage Utilities

1.4 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer's specifications and technical data including performance, construction, and fabrication information.
      1. Submit for manholes, frames, and covers.
   C. Field Quality Control submittals as specified in Part 3 of this Section:
      1. Field Tests
      2. Special Inspections for Code Compliance.
   D. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
      1. Provide record documents.

1.5 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than five years of experience in the actual production of specified products.
   B. Installer's Qualifications: Firm with not less than five years of experience in installation of systems similar in complexity to those required for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer's identification.
   B. Storage and Protection: Comply with manufacturer's recommendations.
      1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICES
   A. Notify Engineer at least 48 hours before starting work of this section.

1.8 COORDINATION
   A. Coordinate with other trades affecting or affected by work of this section.
SANITARY UTILITY SEWERAGE MANHOLES, FRAMES AND COVERS

PART 2 - PRODUCTS

2.1 MANHOLE BASES, RISERS, AND CONES

A. Standard precast manhole sections shall conform to ASTM C478 (latest revision) and consist of circular sections in standard nominal diameters. No more than two lift holes shall be cast into each section. Holes shall be located so as to not damage reinforcing or expose it to corrosion. At the manufacturer’s option, steel loops may be provided for handling in lieu of lift holes. Standard precast cones shall be concentric [eccentric] unless otherwise specified and shall conform to ASTM C478 (latest revision).

2.2 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.3 MORTAR

A. Cement mortar in precast manhole joint shall conform to ASTM C387 (latest revision) and consist of one part portland cement and two parts clean, well graded sand which will pass a 1/8” screen with water as necessary to obtain the consistency such that it will readily adhere to the precast concrete. Mortar shall be used within 30 minutes after it is prepared.

2.4 MANHOLE JOINT SEALANT

A. Preformed plastic gaskets, such as Kent Seal, or approved.

2.5 PLASTIC PIPE SEALANT

A. At PVC pipe penetrations: KOR-N-SEAL Boot or approved.

2.6 MANHOLE FRAMES AND COVERS

A. Manhole frames shall have a 24” clear frame opening. Bearing and wedging surface shall be machined to ensure a tight fit of the cover and to prevent rocking.

B. Covers, grates, and frames shall be cast iron conforming to ASTM A48 (latest revision), Class 30.

C. Cover shall be marked “SANITARY”, “SEWER”, “SS”, or other appropriate marking to indicate sanitary sewer system.

D. Covers located in walkways shall be textured to reduce slip hazard. Texture shall be approved by the Architect.

E. University of Oregon sanitary manhole number/ID, as shown on plans [TBD/Coordinated with Facilities], shall be marked on the cover and inside the collar.

F. Covers within concrete pavement areas shall be as follows:
   1. Base Bid: ADA compliant, diamond pattern non-skid surfacing, as approved by the Architect.
SANITARY UTILITY SEWERAGE MANHOLES, FRAMES AND COVERS
PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work of this section, carefully inspect trench, excavations, and base to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 EXCAVATION AND BACKFILL

A. Excavation and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 MANHOLE BASES (WITHOUT SUMP)

A. Manhole bases shall be precast or cast-in-place concrete. Placement of cast-in-place concrete shall conform to Section 03 30 00, CAST-IN-PLACE CONCRETE. If a precast manhole is used, the channels shall be poured and shaped after manhole is in place as indicated on drawings. Base sections shall be constructed to form a watertight structure.

B. Where indicated on drawings, the invert shall be constructed to a section identical with that of the sewer pipe. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces. Where a full section of concrete sewer pipe is laid through the manhole, the top shall be broken out to the spring line of the pipe for the full width of the manhole, and the exposed edge of the pipe completely covered with mortar. During construction, the Contractor shall divert existing flows of water or sewage from new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

C. Construct on 4” minimum depth, 3/4”-0 crushed rock base; level and plumb.

3.4 PIPE OPENINGS

A. Openings to receive pipe shall be circular, tapered in toward the inside of the section and held to the minimum size possible to accommodate the pipe to be inserted and to effectively seal the joints.

B. For PVC pipe make manhole connections using KOR-N-SEAL Boot.

C. Trim pipe ends flush with manhole interior wall. Grout between pipe and manhole for a smooth transition.

3.5 JOINT SEALING

A. Pipe gaskets shall be installed in conformance with the manufacturer's recommendations. All mortar joints shall be clean and wet before setting risers and tops in a full bed of Portland cement mortar. Joints shall be watertight, grouted inside and have a smooth finish. Outside joints shall be grouted before backfilling.
SANITARY UTILITY SEWERAGE MANHOLES, FRAMES AND COVERS

3.6 GRADE RINGS

A. Grade rings shall be laid in mortar with the sides plumb and the top level. The joints shall be sealed with mortar. The extensions shall be watertight.

3.7 MANHOLE FRAMES AND COVERS

A. Frames shall be set in a bed of mortar. Frames shall be set so the rim is flush with adjacent surfaces unless otherwise noted on drawings. Frames and covers shall be installed in such a manner as to prevent infiltration of surface or ground water between the frame and the concrete of the manhole section.

3.8 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Hydrostatic or air test as described below.

C. Field Inspections: Notify Engineer prior to backfilling.

D. Special Inspections for Code Compliance:
   1. Obtain plumbing inspector approvals and submit to Engineer.

3.9 CLEANING

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed systems. All manholes shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Engineer.

B. Upon completion of work of this section, promptly remove from the working area all scraps, debris, and surplus material.

3.10 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. On-site private storm drain system improvements.

1.3 RELATED SECTIONS
   A. Section 31 23 33 - Trenching and Backfill
   B. Section 33 49 13 - Storm Drainage Manholes, Frames, and Covers

1.4 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer's specifications and technical data including performance, construction, fabrication, and installation information.
      1. Submit for: x
   C. Field Quality Control submittals as specified in Part 3 of this Section:
      1. Field Tests
      2. Special Inspections for Code Compliance
   D. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
      1. Provide record documents.

1.5 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
   B. Installer's Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Packing and Shipping: Deliver products in original, unopened packing with legible manufacturer's identification.
   B. Storage and Protection: Comply with manufacturer's recommendations.
      1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICES
   A. Notify Engineer at least 48 hours before starting work of this section.

1.8 COORDINATION
   A. Coordinate with other trades affecting or affected by work of this section.
STORM DRAINAGE UTILITIES

PART 2 - PRODUCTS

2.1 STORM DRAIN PIPE AND FITTINGS (UNLESS OTHERWISE NOTED)

A. Either of the following pipe materials may be used.
   1. Option #1:
      b. Fittings: PVC, ASTM D3034.
      c. Joints: Bell and spigot with rubber gaskets, conform to ASTM D3212 and ASTM F477.
   2. Option #2:
      a. Pipe: Corrugated polyethylene, type S, AASHTO M252 (3”-10”) and AASHTO M294 (12” and larger). Hancor or ADS.
      b. Fittings: Polyethylene, AASHTO M252 or AASHTO M294. Fittings shall be welded to the interior and exterior at all junctions.
      c. Joints: Bell and spigot with polyisoprene gaskets, conform to ASTM F477 and water tight per ASTM D3212. Gaskets shall not have any visible cracking when tested according to ASTM D1149 after 72 hour exposure in 50 PPHM ozone at 104°F. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. Joints shall remain water tight when subjected to a 1.5° axial misalignment. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

2.2 STORM DRAIN PIPE AND FITTINGS (DUCTILE IRON) (BUILDING APPROVED MATERIAL, FOR USE UNDER AND WITHIN 2 FEET OF BUILDING)

A. Conform to Division 22.

2.3 STORM DRAIN PIPE AND FITTINGS (DUCTILE IRON) (BUILDING APPROVED MATERIAL, FOR USE UNDER AND WITHIN 2 FEET OF BUILDING)

A. Shall be cement-lined ductile iron pipe, Class 52, conforming to AWWA C151. Fittings shall be Class 52, conforming to AWWA C153 for mechanical joints pressure rating of 350 psi and AWWA C110 for flange joints pressure rating of 250 psi. Provide with manufactured fittings unless otherwise noted on drawings.

B. Provide pipe wrap, 8 mil polywrap meeting pipe manufacturer's recommendations.

2.4 PERFORATED PIPE AND FITTINGS

A. Shall be smooth interior perforated corrugated polyethylene pipe with AASHTO Type ‘S’ designation meeting the requirements of AASHTO M252 (pipe sizes 4” – 10”) and AASHTO M294 (pipe sizes 12” – 60”). Provide with manufactured fittings unless otherwise noted on drawings.

2.5 SINGLE CHAMBER CATCH BASINS

A. Shall be prefabricated steel, 24 inches square by 36 (minimum) inches deep, 10 gauge minimum, asphalt paint inside and out, 6 inch minimum water seal with hinged lid on trap, outlet size as specified on drawings. Cast iron or steel grate with bicycle bars. Lynch or Gibson. Grated chamber (inlet) to have oil and grease filtration system with filter insert.

B. Use any of the following pipe materials from the catch basin to lateral where cover is less than one foot as detailed on drawings: Ductile Iron pipe and fittings (cement-lined), Class 52, AWWA C151; PVC, AWWA C900, CL150; Schedule 40 PVC, ASTM D2665, F891, or D1785 (latest revision).
2.6 OVERFLOW CATCH BASINS

A. Shall be concrete 24 inches square by 36 (minimum) inches deep, outlet size and configuration as specified on drawings. Cast iron or steel grate with bicycle bars.

B. Use any of the following pipe materials from the catch basin to lateral where cover is less than one foot as detailed on drawings: Ductile Iron pipe and fittings (cement-lined), Class 52, AWWA C151; PVC, AWWA C900, CL150; Schedule 40 PVC, ASTM D2665, F891, or D1785 (latest revision).

2.7 AREA DRAINS

A. Shall be prefabricated steel, 12 inches diameter [square] by 24 (minimum) inches deep, 10 gauge minimum, asphalt paint inside and out, 6 inch minimum water seal with hinged lid on trap, outlet size as specified on drawings. Cast iron or steel grate with bicycle bars. Lynch or Gibson.

2.8 DECK DRAINS

A. Shall be fabricated steel body and cast iron grate, [nickel bronze] grate with galvanized sub-coat, Duco finish inside and outside and stainless steel ported bucket with mesh screen and lift bar. [ADA-compliant and heel-proof grate.] Side outlet, [bottom outlet] outlet pipe size 4 inch [6 inch]. JR Smith 2245 [2240][bottom outlet].

2.9 FLEXIBLE TRANSITION COUPLING

A. Shall be Fernco, 1000 series. Use fittings manufactured for the specific pipe size and material types being connected.

2.10 CLEANOUTS

A. Shall be constructed from solid wall pipe and fittings specified above with traffic grade frame and cover. Frame and cover shall be H20 rated cast iron valve box with flange top as detailed on drawings with "storm" marking. Olympic Foundry VB910 Valve Box.

2.11 TRENCH DRAIN

A. Trench Drain Channel Section:
   1. Precast polymer concrete pre-sloped channel sections with interlocking joints and horizontal cast-in anchoring features to ensure maximum mechanical bond to the surrounding concrete, ACO model K100S.
   2. 4” nominal clear opening width, 5.1” overall width, 0.6% channel slope. Provide with endcaps at upstream end of channel per manufacturer recommendations. Provide with non-standard 811 type bolt-down locking system to accommodate grate per manufacturer recommendations. Provide outfall to trench drain sediment trap as shown on Drawings.

B. Trench Drain Sediment Trap:
   1. In-Line Catch Basin, 24” overall depth, 4” wide grate section, matching horizontal dimensions of adjacent channel sections, ACO model K900 outlet F. Provide with non-standard 811 type bolt-down locking system to accommodate grate per manufacturer recommendations. Provide with removable trash basket, ACO series 900.

C. Trench Drain Grate:
   1. 4.9” wide “Viper” grate by Urban Accessories
   2. Ductile Iron per ASTM A536, Class 65-45-12
STORM DRAINAGE UTILITIES

2.12 TERMINAL BACKWATER VALVE
A. Terminal Valve, Duco cast iron body and bronze valve seat with hub inlet and open outlet for installation at the end of drainage line. Jay R. Smith 7070, Zurn Z1091 or approved equal.

2.13 FILTRATION RAIN GARDENS AND PLANTERS
A. Construct as shown on the drawings and per Section 31 20 00.

2.14 CONCRETE
A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1½ inches.

2.15 OTHER MATERIALS
A. Recommended by Manufacturer and subject to Engineer's review and acceptance. Provide all materials required to complete and make drainage system operational.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS
A. Prior to starting work of this section, carefully inspect trench, excavations, and pipe bedding to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 TRENCHING AND BACKFILL
A. Trenching and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 PIPE INSTALLATION
A. Installation shall be in accordance with the manufacturer's recommendation. All pipe ends and interiors shall be thoroughly cleaned of all foreign matter and shall be kept clean during installation. When work is not in progress, all open ends of pipe and fittings shall be securely closed so that no water, earth, animal life, or other substance may enter.

B. Cutting pipe shall be done in a neat and workmanlike manner by method which will not damage pipe and as recommended by manufacturer.

C. Install piping within 0.02 foot of indicated grade and location.

D. Trim pipe ends flush with manhole and catch basin interior walls.

E. All ductile iron pipe joints and fitting joints within 5 feet of building and beneath building shall be fully covered with asphaltic coating. Wrap ductile iron pipe and fittings within 5 feet of building and beneath building with Polywrap.
STORM DRAINAGE UTILITIES

3.4 CATCH BASINS, AREA DRAINS, OVERFLOW CATCH BASINS, AND DECK DRAINS

A. Construct on compacted 4" minimum depth, 3/4" - 0 crushed rock base level, plumb, and square with adjacent construction. Set rim flush with adjacent finished surfaces unless otherwise noted.

3.5 CLEANOUTS

A. Construct on compacted 4" minimum depth 3/4" - 0 crushed rock base level, plumb, and square with adjacent surfaces. Set rim flush with adjacent finished surfaces unless otherwise noted.

3.6 TRENCH DRAIN

A. Install in accordance with manufacturer’s recommendations as detailed on drawings.

B. Construct level, plumb, and square with adjacent construction. Set trench drain channel completely in place, and test flow from both directions of flow prior to pouring concrete. Set rim flush with adjacent finished surfaces unless otherwise noted.

C. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other devices and materials recommended by system manufacturer.

D. Embed channel sections in 6" minimum concrete collar, as shown on the drawings.

E. Assemble channel sections with flanged or interlocking joints.

F. Install trench drain sediment trap at end of trench drain per manufacturer recommendations.

G. Core holes for pipe penetrations at elevations shown on the plans. Seal pipe penetrations per manufacturer recommendations.

3.7 BACKWATER VALVE

A. Install per manufacturer’s recommendations and as detailed on drawings.

3.8 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. TV Inspections and Reports:
      a. Provide for all storm drain pipe 8 inch diameter and larger.
   2. Deflection Test:
      a. Conduct deflection tests of flexible pipe. The testing shall be conducted by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95 percent of the pipe initial inside diameter. Conduct testing on a manhole-to-manhole basis after flushing and cleaning.
      b. The mandrel shall be pulled in front of the camera so the deflection testing is clearly recorded on the video tape unless approved by the Engineer.
      c. A water depth gauge shall be provided, located on the TV camera side of the mandrel. The gauge shall be graduated with marks at 0.50" increments clearly visible during TV inspection. The gauge shall be capable of measuring depth of water in 0.50" increments from 0.50" to 2.5". The gauge shall be designed so it will remain plumb regardless of the rotation of the mandrel or camera.
      d. Deflection testing shall be conducted and accepted prior to any paving being done.

C. Field Inspections: Notify Engineer prior to work of this section.
STORM DRAINAGE UTILITIES

D. Special Inspections for Code Compliance: Obtain plumbing inspector approvals.

3.9 CLEANING

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed system. All pipe and structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Engineer.

B. Upon completion of work of this section promptly remove from the working area all scraps, debris, and surplus material.

3.10 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.1 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.2 SECTION INCLUDES
   A. Manholes for on-site private storm drain system improvements.

1.3 RELATED SECTIONS
   A. Section 31 23 33 - Trenching and Backfill
   B. Section 33 40 00 - Storm Drainage Utilities

1.4 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer's specifications and technical data including performance, construction and fabrication information.
      1. Submit for manholes, frames, and covers.
   C. Field Quality Control submittals as specified in Part 3 of this Section:
      1. Field Tests
      2. Special Inspections for Code Compliance.
   D. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
      1. Provide record documents.

1.5 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than five years of experience in the actual production of specified products.
   B. Installer's Qualifications: Firm with not less than five years of experience in installation of systems similar in complexity to those required for this Project.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Packing and Shipping: Deliver products in original, unopened packaging with legible manufacturer's identification.
   B. Storage and Protection: Comply with manufacturer's recommendations.
      1. Protect from damage by the elements and construction procedures.

1.7 ADVANCE NOTICES
   A. Notify Engineer at least 48 hours before starting work of this section.

1.8 COORDINATION
   A. Coordinate with other trades affecting or affected by work of this section.
STORM DRAINAGE MANHOLES, FRAMES AND COVERS

PART 2 - PRODUCTS

2.1 MANHOLE BASES, RISERS, AND CONES

A. Standard precast manhole sections shall conform to ASTM C478 (latest revision) and consist of circular sections in standard nominal diameters. No more than two lift holes shall be cast into each section. Holes shall be located so as to not damage reinforcing or expose it to corrosion. At the manufacturer's option, steel loops may be provided for handling in lieu of lift holes. Standard precast cones shall be eccentric unless otherwise specified and shall conform to ASTM C478 (latest revision).

2.2 CONCRETE

A. Concrete shall be ready-mixed conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE, and shall have a compressive strength of 3,000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.3 MORTAR

A. Cement mortar in precast manhole joint shall conform to ASTM C387 (latest revision) and consist of one part portland cement and two parts clean, well graded sand which will pass a 1/8" screen with water as necessary to obtain the consistency such that it will readily adhere to the precast concrete. Mortar shall be used within 30 minutes after it is prepared.

2.4 MANHOLE JOINT SEALANT

A. Preformed plastic gaskets, such as Kent Seal, or approved.

2.5 PLASTIC PIPE SEALANT

A. At PVC pipe penetrations: KOR-N-SEAL Boot or approved.

2.6 MANHOLE FRAMES AND COVERS

A. Manhole frames shall have a 24" clear frame opening. Bearing and wedging surface shall be machined to ensure a tight fit of the cover and to prevent rocking.

B. Covers, grates, and frames shall be cast iron conforming to ASTM A48 (latest revision), Class 30.

C. Cover shall be marked "STORM", "SD", or other appropriate marking to indicate sanitary sewer system.

D. Covers located in walkways shall be textured to reduce slip hazard. Texture shall be approved by the Architect.

E. University of Oregon sanitary manhole number/ID, as shown on plans [TBD/Coordinated with Facilities], shall be marked on the cover and inside the collar.

F. Covers within concrete pavement areas shall be as follows:
   1. Base Bid: ADA compliant, diamond pattern non-skid surfacing, as approved by the Architect.
   2. Alternate: Custom-cast Urban Accessories "Viper" pattern, matching trench drain and tree grates.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to starting work of this section, carefully inspect trench, excavations, and base to verify that all such work is complete to the point where this installation may properly commence.

B. Do not install work of this section until unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.2 EXCAVATION AND BACKFILL

A. Excavation and backfill shall conform to the requirements of Section 31 23 33, TRENCHING AND BACKFILL.

3.3 MANHOLE BASES (WITHOUT SUMP)

A. Manhole bases shall be precast or cast-in-place concrete. Placement of cast-in-place concrete shall conform to Section 03 30 00, CAST-IN-PLACE CONCRETE. If a precast manhole is used, the channels shall be poured and shaped after manhole is in place as indicated on drawings. Base sections shall be constructed to form a watertight structure.

B. Where indicated on drawings, the invert shall be constructed to a section identical with that of the sewer pipe. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces. Where a full section of concrete sewer pipe is laid through the manhole, the top shall be broken out to the spring line of the pipe for the full width of the manhole, and the exposed edge of the pipe completely covered with mortar. During construction, the Contractor shall divert existing flows of water or sewage from new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.

C. Construct on 4" minimum depth, 3/4"-0 crushed rock base; level and plumb.

3.4 MANHOLE BASES (WITH SUMP)

A. Manhole bases shall be precast. Base sections shall be constructed to form a watertight structure.

B. Construct on 4" minimum depth, 3/4"-0 crushed rock base; level and plumb.

3.5 PIPE OPENINGS

A. Openings to receive pipe shall be circular, tapered in toward the inside of the section and held to the minimum size possible to accommodate the pipe to be inserted and to effectively seal the joints.

B. For PVC pipe make manhole connections using KOR-N-SEAL Boot.

C. For corrugated pipe, make manhole connections using cement bender product X or approved.

D. Trim pipe ends flush with manhole interior wall. Grout between pipe and manhole for a smooth transition.
STORM DRAINAGE MANHOLES, FRAMES AND COVERS

3.6 JOINT SEALING

A. Pipe gaskets shall be installed in conformance with the manufacturer's recommendations. All mortar joints shall be clean and wet before setting risers and tops in a full bed of Portland cement mortar. Joints shall be watertight, grouted inside and have a smooth finish. Outside joints shall be grouted before backfilling.

3.7 GRADE RINGS

A. Grade rings shall be laid in mortar with the sides plumb and the top level. The joints shall be sealed with mortar. The extensions shall be watertight.

3.8 MANHOLE FRAMES AND COVERS

A. Frames shall be set in a bed of mortar. Frames shall be set so the rim is flush with adjacent surfaces unless otherwise noted on drawings. Frames and covers shall be installed in such a manner as to prevent infiltration of surface or ground water between the frame and the concrete of the manhole section.

3.9 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Inspections: Notify Engineer prior to backfilling.

C. Special Inspections for Code Compliance:
   1. Obtain plumbing inspector approvals and submit to Engineer.

3.10 CLEANING

A. Prior to final acceptance, Contractor shall flush and clean all elements of the completed systems. All manholes shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the Engineer.

B. Upon completion of work of this section, promptly remove from the working area all scraps, debris, and surplus material.

3.11 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION
PART 1 - GENERAL

1.01 CONTRACT CONDITIONS
   A. Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this specification and accompanying drawings.

1.02 SECTION INCLUDES
   A. Private on-site natural gas distribution system improvements.

1.03 WORK INCLUDED BUT SPECIFIED IN OTHER SECTIONS
   A. Section 31 23 33 - Trenching and Backfill.

1.04 WORK PROVIDED BY OTHERS
   A. Natural gas distribution system piping, meters, and connections by Northwest Natural Gas Co.

1.05 SUBMITTALS
   A. Comply with Section 01 33 00, unless otherwise indicated.
   B. Product Data: Manufacturer's specifications and technical data including performance, construction, and fabrication information.
      1. Submit for pipe and fittings.
   C. Closeout Requirements: Comply with Section 01 77 00 and Section 01 78 00.
      1. Provide record documents.

1.06 QUALITY ASSURANCE
   A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
   B. Installers Qualifications: Firm with not less than 5 years experience in installation of systems similar in complexity to those required for this project.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Delivery, Storage and Protection: Comply with manufacturer's recommendations.
      1. Protect from damage by the elements and construction procedures.

1.08 ADVANCE NOTICES
   A. Notify Engineer at least 48 hours before starting work of this section.

1.09 COORDINATION
   A. Coordinate with other trades affecting or affected by work of this section.

PART 2 - PRODUCTS

2.01 GAS DISTRIBUTION PIPE AND FITTINGS
   A. Provided by NW Natural
2.02 CONDUIT

A. Provided by NW Natural

B. Contractor has option of picking up conduit from Northwest Natural Gas’ yard or requesting delivery by Northwest Natural Gas to the jobsite.

2.03 OTHER MATERIALS

A. Recommended by manufacturer and subject to Engineer’s review and acceptance. Provide all materials required to complete and make natural gas system operational.

PART 3 - EXECUTION

3.01 EXISTING CONDITIONS

A. Prior to starting of the work of this section carefully inspect trench, excavations, and pipe bedding to verify that all such work is complete to the point where this installation may properly commence.

B. Do not start work of this section until all unsatisfactory conditions have been corrected. Commencing work implies acceptance of existing conditions.

C. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If measurements differ substantially, notify Engineer prior to starting work of this section.

3.02 TRENCHING AND BACKFILL

A. Trenching and backfill shall conform to the requirements of Section 31.23.33, TRENCHING AND BACKFILL.

3.03 PIPE INSTALLATION

A. By Northwest Natural. Contractor shall coordinate with Northwest Natural’s commercial marketing personnel then contact Northwest Natural three (3) business days prior to the trench being opened. Northwest Natural will then have the service line installed within four (4) business days of the trench being opened.

3.04 CONDUIT INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendation. All pipe ends and interiors shall be thoroughly cleaned of all foreign matter and shall be kept clean during installation. When work is not in progress, all open ends of pipe and fittings shall be securely closed so that no water, earth, animal life, or other substance may enter.

B. Cutting pipe shall be done in a neat and workmanlike manner by method which will not damage pipe and as recommended by manufacturer.

C. Install piping within 0.02 foot of indicated grade and location.

D. Install and test in accordance with NFPA 54 and applicable local codes.

E. In addition to tracer wire, provide metallic detection tape, marked "gas pipe below", buried 6 inches below grade, directly above plastic gas pipe.
F. Connections between plastic and steel gas pipe shall be made underground with ASTM D-2513 (latest revision) Category 1 mechanical joint transition fittings, which provide a seal and resistance to pullout.

G. Apply tape to both ends of conduit prior to backfilling.

H. Mark both ends of pipe so that Northwest Natural Gas can locate the conduit when making the connection to the main and to the new gas meter.

3.05 FIELD QUALITY CONTROL

A. Refer to Section 01 45 00 for responsibilities for arranging, supervising, and payment of field quality control requirements.

B. Field Tests:
   1. Hydrostatic or air test as described below.

C. Field Inspections: Notify Engineer prior to work of this Section.

D. Special Inspections for Code Compliance:
   1. Test per NFPA 54 and as required by Oregon State Plumbing Specialty code.
   2. Notify Engineer 48 hours prior to testing and inspection procedures.
   3. Obtain plumbing inspector approvals.

3.06 CLEANING

A. Prior to final acceptance, contractor shall flush and clean all elements of the completed system. All pipe structures shall be clean and free of all construction debris, rocks, gravel, mud, sand, silt, and other foreign material, and as directed by the general contractor.

B. Upon completion of work of this section promptly remove from the working area all scraps, debris and surplus material.

3.07 PROTECTION

A. Protect all work installed under this section.

B. Replace, at no additional cost to Owner, any damaged work of this section.

END OF SECTION