PROJECT MANUAL

FOR:

RENAISSANCE HIGH SCHOOL
BID SET
1307 E CENTRAL DRIVE
MERIDIAN, IDAHO 83642

January 12, 2018

Owner:

WEST ADA SCHOOL DISTRICT
1303 E CENTRAL DRIVE
MERIDIAN, IDAHO 83642

Architect:

HUMMEL ARCHITECTS PLLC

HA PROJECT NO. 17015
# Table of Contents

## Volume 1:

### BIDDING REQUIREMENTS
- Advertisement for Bids
- Invitation to Bid and Bid Form
- AIA A701 - 1997 - Instructions to Bidders
- Supplemental Instructions to Bidders
- General Requirements – All Bid Packages
- Bid Package Descriptions and Requirements (BP-1 to BP-10)
- Bidders Checklist
- Project Schedule
- AIA A101 2017 - Standard Form of Agreement Between Owner and Contractor
- AIA A201 - 2017 – General Conditions of the Contract for Construction
- WH-5 Form – State Tax Commission Public Works Contract Report

### DIVISION 01 - GENERAL REQUIREMENTS
- 011000 SUMMARY
- 012300 ALTERNATES
- 012600 CONTRACT MODIFICATION PROCEDURES
- 012900 PAYMENT PROCEDURES
- 013100 PROJECT MANAGEMENT AND COORDINATION
- 013300 SUBMITTAL PROCEDURES
- 014000 QUALITY REQUIREMENTS
- 014200 REFERENCES
- 015000 TEMPORARY FACILITIES AND CONTROLS
- 016000 PRODUCT REQUIREMENTS
- 017300 EXECUTION REQUIREMENTS
- 017329 CUTTING AND PATCHING
- 017700 CLOSEOUT PROCEDURES

## Volume 2:

### DIVISION 02 – EXISTING CONDITIONS
- 024119 SELECTIVE STRUCTURE DEMOLITION

### DIVISION 03 - CONCRETE
- 033000 CAST-IN-PLACE CONCRETE
- 035313 POLISHED CONCRETE FINISHING

### DIVISION 05 - METALS
- 051200 STRUCTURAL STEEL FRAMING
- 053100 STEEL DECKING
- 054000 COLD-FORMED METAL FRAMING
- 055000 METAL FABRICATIONS
- 055213 PIPE AND TUBE RAILINGS

### DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES
- 061053 MISCELLANEOUS ROUGH CARPENTRY
- 064023 INTERIOR ARCHITECTURAL WOODWORK

### DIVISION 07 - THERMAL AND MOISTURE PROTECTION

## TABLE OF CONTENTS
<table>
<thead>
<tr>
<th>Division</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>072100</td>
<td>Building Insulation</td>
</tr>
<tr>
<td>075423</td>
<td>Thermoplastic Polyolefin (TPO) Roofing</td>
</tr>
<tr>
<td>079200</td>
<td>Joint Sealants</td>
</tr>
<tr>
<td><strong>Division 08 - Openings</strong></td>
<td></td>
</tr>
<tr>
<td>081113</td>
<td>Hollow Metal Doors and Frames</td>
</tr>
<tr>
<td>081416</td>
<td>Flush Wood Doors</td>
</tr>
<tr>
<td>083113</td>
<td>Access Doors and Frames</td>
</tr>
<tr>
<td>083326</td>
<td>Overhead Coiling Grilles</td>
</tr>
<tr>
<td>083613</td>
<td>Sectional Doors</td>
</tr>
<tr>
<td>084113</td>
<td>Aluminum-Framed Entrances and Storefronts</td>
</tr>
<tr>
<td>087100</td>
<td>Door Hardware</td>
</tr>
<tr>
<td>088000</td>
<td>Glazing</td>
</tr>
<tr>
<td><strong>Division 09 - Finishes</strong></td>
<td></td>
</tr>
<tr>
<td>092213</td>
<td>Gypsum Board Shaft-Wall Assemblies</td>
</tr>
<tr>
<td>092216</td>
<td>Non-Structural Metal Framing</td>
</tr>
<tr>
<td>092900</td>
<td>Gypsum Board</td>
</tr>
<tr>
<td>095113</td>
<td>Acoustical Panel Ceilings</td>
</tr>
<tr>
<td>096513</td>
<td>Resilient Base and Accessories</td>
</tr>
<tr>
<td>098319</td>
<td>Acoustical Wall Panels</td>
</tr>
<tr>
<td>099123</td>
<td>Interior Painting</td>
</tr>
<tr>
<td><strong>Division 10 - Specialties</strong></td>
<td></td>
</tr>
<tr>
<td>101100</td>
<td>Visual Display Surfaces</td>
</tr>
<tr>
<td>101400</td>
<td>Signage</td>
</tr>
<tr>
<td>102123</td>
<td>Cubicle Curtains</td>
</tr>
<tr>
<td>102800</td>
<td>Toilet, Bath and Laundry Accessories</td>
</tr>
<tr>
<td>104413</td>
<td>Fire Protection Specialties</td>
</tr>
<tr>
<td><strong>Division 11 - Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>113100</td>
<td>Residential Appliances</td>
</tr>
<tr>
<td>115313</td>
<td>Laboratory Fume Hoods</td>
</tr>
<tr>
<td>117300</td>
<td>Ceiling Mounted Patient Lift System</td>
</tr>
<tr>
<td><strong>Division 12-14 (No Requirements)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Volume 3:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Divisions 15 – 20 (No Requirements)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Division 21 - Fire Suppression</strong></td>
<td></td>
</tr>
<tr>
<td>210000</td>
<td>Fire Sprinkler Systems</td>
</tr>
<tr>
<td><strong>Division 22 - Plumbing Systems</strong></td>
<td></td>
</tr>
<tr>
<td>220000</td>
<td>Plumbing General Requirements</td>
</tr>
<tr>
<td>220100</td>
<td>Plumbing</td>
</tr>
<tr>
<td><strong>Division 23 - HVAC Systems</strong></td>
<td></td>
</tr>
<tr>
<td>230000</td>
<td>HVAC General Requirements</td>
</tr>
<tr>
<td>230100</td>
<td>Heating, Ventilating, and Air Conditioning</td>
</tr>
<tr>
<td>230150</td>
<td>Mechanical Start-Up</td>
</tr>
</tbody>
</table>
230900  DDC CONTROL SYSTEM

**DIVISIONS 24 – 25 (NO REQUIREMENTS)**

**DIVISION 26 – ELECTRICAL**
- 260500  ELECTRICAL GENERAL PROVISIONS
- 260502  SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS
- 260519  CONDUCTORS AND CABLES
- 260626  GROUNDING
- 260533  RACEWAYS AND BOXES
- 260536  CABLE TRAYS
- 260800  LIGHTING SYSTEMS COMMISSIONING^2
- 260923  LIGHTING CONTROL DEVICES
- 262416  PANELBOARDS
- 262418  MOTOR STARTERS
- 262726  WIRING DEVICES
- 262815  DISCONNECT SWITCHES
- 265100  INTERIOR LIGHTING
- 266000  ELECTRICAL DEMOLITION AND REPAIR

**DIVISION 27 – COMMUNICATIONS**
- 271101  TELECOM RACEWAY SYSTEMS
- 271300  COMMUNICATIONS CABLES
- 275116  PUBLIC ADDRESS SYSTEMS
- 275313  CLOCK SYSTEMS

**DIVISION 28 – ELECTRONIC SAFETY AND SECURITY**
- 283100  FIRE ALARM SYSTEM

**DIVISION 29 – 33 (NO REQUIREMENTS)**

END OF TABLE OF CONTENTS
DIVISION 21 – FIRE SUPPRESSION

SECTION 210000 - FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE:

A. General:
   1. Specification Section 220000, Plumbing General Requirements, is to be included as part of this Section of the specification.

B. Work Included:
   1. This section covers the work necessary to design and modify the existing fire sprinkler system for a complete, satisfactory, and ready to operate wet pipe fire protection system for heated areas and dry pipe fire protection system for non-heated areas (areas subject to freezing). Hazard classification shall be as required by the State Fire Marshal, local City, IBC, IFC, and applicable NFPA Standards.

C. Qualifications of Installer:
   1. All work shall be performed by a qualified, competent, licensed Fire Sprinkler Contractor who can furnish a verified list of satisfactory installations of this type and size, for a period of 5 years or more. Fire sprinkler contractor shall be licensed by the Idaho State Fire Marshal, and shall have in his employ an Engineering Technician (Level III), certified by NICET (National Institute for Certification in Engineering Technologies).

D. System Responsibility:
   1. All work required for the fire protection system, including design and installation, shall be the responsibility of the Fire Sprinkler Contractor. Coordination with other trades is critical. Contractor shall coordinate his work with all ductwork, piping, electrical, etc., to ensure that all systems can be installed with a minimum of interference. Sprinkler heads shall be located in the center of ceiling tiles in the 2’ dimension and quarter spaced on 12” increments in the 4’ dimension. All piping penetrations through finished walls shall be provided with chrome escutcheons. Submittals which are required are only for the purpose of general coordination. Architect/Engineer assumes no responsibility or liability for the design of the system.

2. All monitoring of valves not shown on the electrical drawings shall be within the scope of work for the fire sprinkler contractor. This shall include, but not be limited to, the following: All conduit and wiring as required to monitor post indicator valves, tamper switches, and any other devices required to be supervised by the fire alarm panel. The sprinkler contractor shall also provide all power, wiring and conduit required for a complete and operational dry-pipe system (if required), unless such electrical is shown on the electrical drawings.

3. All dry piping shall be graded to drain back to the riser, regardless of location or presence of heat. Where not possible, piping may be graded to auxiliary drum drip drains. All locations of drains are
to be approved by the Architect/Engineer prior to installation. All exposed piping shall be installed as close to ceilings as possible while maintaining appropriate sprinkler deflector clearances and while providing minimum pipe grade per NFPA 13 requirements. Piping shall be designed and installed in a neat and symmetrical manor and shall be coordinated with all other trades and building features.

4. All wet piping may be installed flat and level but shall be installed so as to minimize the requirements for auxiliary drains. All exposed piping shall be installed as close to ceilings as possible while maintaining appropriate sprinkler deflector clearances. Piping shall be designed and installed in a neat and symmetrical manor and shall be coordinated with all other trades and building features.

5. Submittals are required are only for the purpose of general coordination. Architect/Engineer assumes no responsibility or liability for the design of the system.

1.2 CODES AND STANDARDS:

A. The sprinkler system is to be designed and installed in accordance with the latest applicable building codes, State and Local Fire Marshals requirements, and all applicable NFPA Standards.

PART 2 - PRODUCTS

2.1 SUBMITTALS:

A. The Engineering Technician shall prepare and submit the following submittal data:

1. Complete equipment list of all equipment to be installed, including manufacturer’s name and catalog number.

2. Layout drawing of complete sprinkler system indicating relationship of all other overhead items, including ductwork, lights, and structural members.

3. Complete details and sections as required to clearly define and clarify the design.

4. Plot plan indicating location of all underground connections, piping, valves, and related items.

5. Complete building section showing location of piping, sprinklers and applicable equipment in relation to other construction features.

6. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable style or series number.

7. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

8. Sprinklers valve and equipment model numbers shall be specifically identified on drawings and shall match submittal data provided.
2.2 MATERIALS AND EQUIPMENT:

A. All materials shall be as specified below, or in accordance with applicable NFPA Standards:

1. Piping shall be black steel per NFPA 13 requirements and shall have a factory applied interior MIC or corrosion resistant coating. Piping shall be new and relatively free of exterior rust or corrosion. Piping with excessive rust or corrosion may be rejected. Threadable, thin wall piping will not be allowed. CPVC is allowed for underground only.

2. Fittings shall be 125 psi screwed cast or malleable iron for all threaded piping.

3. Fittings shall be Victaulic FireLock®, Anvil Gruviok, Grinnell or Shurjoint fire protection products for all grooved or plain end piping. Couplings shall consist of two ductile iron housings conforming to ASTM A536, a pressure responsive elastomer gasket, and zinc electroplated carbon steel bolts and nuts. Rigid type or flexible type where necessary.
   a. Rigid Type: Housings shall be cast to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer’s recommendations. Contractor shall remove and replace any improperly installed joints. 1 1/4” and Larger: Standard rigid joint equal to Victaulic FireLock® Style 009 or equal.
   b. Flexible Type: Use in seismic areas where required by NFPA 13, Victaulic Style 75 or 77 or equal.

4. Wet pipe risers shall be equipped with a Reliable brand alarm valve / system check valve.

5. Butterfly control valves with supervisory tamper devices shall be installed for system control.

6. All materials and equipment shall conform to the requirements of Underwriter Laboratories (UL) or Factory Mutual Global (FMG), and shall be so stamped.

7. Pressure switches (water flow device) shall be installed in each system riser (dry pipe systems).

8. Flow switches (water flow device) shall be installed in each system riser (wet pipe systems).

9. Sway Bracing, both lateral and longitudinal, shall be required and shall be installed per applicable NFPA Standards.

10. Sprinkler heads shall match existing style. Escutcheons shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer. Where piping is exposed, install standard bronze upright or pendent sprinklers. Quick response dry sidewall sprinklers shall be used as required to comply with IBC requirements for exterior canopies.

11. Provide 12 extra sprinkler heads mounted together in a suitable cabinet. Include Reliable brand sprinkler head wrenches matching each type of sprinkler head. Include spares of all types of sprinklers installed in the building.

12. Hangers, drains, and Inspectors Test Connections shall be installed in accordance with applicable NFPA Standards.
13. Test and Drain Valve: Globe design valve providing test port with ½” integral orifice and drain port in one unit. Bronze body with copper alloy internals, polycarbonate sight glasses, Nitrile o-rings and EPDM valve seats.

14. All piping penetrations through finished walls shall be provided with chrome escutcheons.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Upon completion of the system, secure the inspection of the required authorities and perform such tests as may be required to demonstrate compliance with local and state standards. Upon acceptance of the system by the inspecting authority, inform the Architect/Engineer in writing, showing proof of acceptance. Submit all required test certificates to required authorities.

B. The Fire Sprinkler Contractor shall monitor the nitrogen percentages until the system has reached 98% pure nitrogen and shall provide written verification, signed and acknowledged by the Owner’s representative of such achievement. This shall occur each time that the system is taken in and out of service for any reason connected to the requirements of the project.

3.2 INSTALLATION:

A. Grooved joint piping systems shall be installed in accordance with the manufacturer’s guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by grooved pipe manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Contractor’s field personnel shall be properly trained in the installation of the manufacturer’s grooved piping products. A Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

B. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

END OF SECTION 210000
PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 01) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete plumbing systems as described.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in every respect, and suitable for the space required. Use the same manufacturer for products of similar class or service, such as valves and pumps. Protect all materials against loss, theft, or damage before and after
2. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.

3. Provide all required firestopping at piping penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be Dow Corning Fire Stop Sealant 2000 or Fire Stop Foam 2001, or approved equal.

4. Provide a heat-expanding fire collar for all non-metallic piping up to 6” size at penetrations of fire rated walls, floors, and ceilings per ASTME 814.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.

2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide all sleeves and inserts required before the floors and walls are built.

3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer’s trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide six copies of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer’s name, and trade designation of all materials and equipment. Submittal shall also include manufacturer’s complete specification for each item, including ratings, and dimensions as required to check space requirements. Provide six copies of all submittals. The scheduled equipment is the basis of design for physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural and Mechanical systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier. Submittals for fixtures, trim, and other plumbing related items, requiring submittals, shall be submitted in a single complete package. Individual items will not be reviewed independently unless approved by the Engineer. Electronic submittals will be
allowed when approved by the Architect and, or Owner. The requirements of electronic submittals are the same as those noted above.

2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect’s /Engineer’s attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:
   1. Plumbing Fixtures & Trim
   2. Valves
   3. Cast Iron Soil Piping
   4. Pipe Stands

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:

A. Accessibility:
   1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.

   2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, model AHD, or equal. Size as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

B. Safety:
   1. No water piping shall run immediately over or within a 3-foot plan view clearance of any electrical panel or motor starter. Where piping must be located within these zones, install piping inside a conduit to prevent water access to electrical equipment.

3.2 COORDINATION:

A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of piping and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.
B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 EXCAVATION & BACKFILL:

A. Excavate trenches required for underground piping to proper elevation and grade. Provide trenches with solid bottoms to allow support of piping along entire length with excavation at bells as required for jointing and inspection. Provide repairing of finished surfaces, and all required shoring, bracing, pumping, and protection for safety of persons and property. Observe all Local or State Safety Codes. Verify that elevations of existing utilities will allow for proper grading of piping connecting to existing utilities.

B. Excavation and Backfill shall be in accordance with the requirements of Division 31, of these specifications.

3.4 IDENTIFICATION AND CODING:

A. General:

1. The Contractor shall use ASME 13 standards for all piping identifications, color coding, and compliance.

B. Painting:

1. All painting of equipment, accessories, and piping shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.

C. Piping:

1. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.

D. Valves:

1. Regardless of size, all valves shall be tagged with a numbered brass tag, 1-1/2 inches by 3 inches minimum in size and 0.051 inch thick. A valve chart indicating valve tag number, location, service, and normal position shall be mounted in a suitable framed and glassed cover in the main mechanical room or as directed. Valve chart shall be duplicated in the Maintenance and Operations Manual.

3.5 TESTING:
A.  Piping:

1. All plumbing piping (drainage, water, gas) shall be tested in accordance with the requirements of local adopted plumbing code, latest edition. Other piping systems shall be tested hydrostatically to 1.5 times the operating pressure but not less than 100 psi, for a minimum period of two hours. If the test pressure falls more than 5 percent during the test period, the leak shall be located, repaired, and the test repeated.

2. Piping shall be tested before insulation has been installed. Delicate control mechanisms shall be removed during tests to prevent shock damage. The use of chemicals or compounds to stop leaks shall not be permitted.

3. A test report shall be submitted for each piping system test. Test report forms are part of Specifications Section 220100, or are available from the Engineer.

B. Systems:

1. All plumbing systems shall be tested at the completion of the building to establish that the systems operate as specified and required.

3.6 CLEANING AND ADJUSTING:

A. Thoroughly clean all parts of the system at the completion of the work. Flush all water circulating systems with fresh water and then drain. Clean all strainers and refill system. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

B. All potable water systems shall be flushed and disinfected after tests are completed. Disinfection shall be in accordance with local municipal and State Plumbing Inspector’s criteria. In lieu of such criteria, the following procedure shall be followed for disinfection:

1. Completely flush system. Add alkali or acid (hydrochloric) to bring water ph level to between 7.4 and 7.6.

2. Inject chlorine (liquid, powder, tablet, or gas) throughout the system to obtain 50 to 80 mg/L residual.

3. Bleed water from outlets to ensure distribution, and test for residual at a minimum of 15 percent of the outlets.

4. Maintain disinfection in system for 24 hours.

5. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

6. Flush disinfectant from system until residual is equal to that of incoming water, or 1.0 mg/L.

7. Take samples no sooner than 24 hours after flushing, from 10 percent of the outlets and the incoming water.

3.7 PROJECT CLOSEOUT:
A. Operations & Maintenance Manual:

The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:

1. Maintenance instructions for all equipment, including lubrication requirements.
2. Fixture suppliers names, addresses, and telephone numbers.
3. Fixture catalog cuts, ratings tables, model numbers, serial numbers, and accessories.
4. Parts numbers for all replaceable parts.
5. Valve tagging chart as hereinbefore specified.
7. Any additional information required to enable the Owner to properly maintain the building plumbing system.
8. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

B. As-Built-Drawings:

1. Provide two sets of blue-line mechanical drawings showing the work as it was actually installed. The drawings shall indicate all departures from the contract drawings, and shall locate all underground utility lines with dimensions from established building lines. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Plumbing Contractor, and returned to the Architect/Engineer.

C. Guarantee:

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

END OF SECTION 220000
RENAISSANCE HIGH SCHOOL – TENANT IMPROVEMENT  
MERIDIAN, IDAHO  
HA PROJECT #17015  

SECTION 220100 - PLUMBING

PART I - GENERAL

1.1 SCOPE:

A. This section covers the work necessary for the plumbing system, complete. The Plumbing General Requirements, Section 220000, are to be included as a part of this section of the specifications.

1.2 CODES:

A. The plumbing system shall be installed in accordance with the requirements of local adopted plumbing code, latest edition, International Fuel Gas Code, latest edition; and all local and State Codes.

1.3 FIXTURES & EQUIPMENT:

A. General:

1. Plumbing fixtures and equipment shall be as listed on the drawings. In addition to those specifically listed, the following manufacturers are approved for bidding only. All other manufacturers require prior approval. Final approval for installation is based on submittal data furnished:


e. Stainless Steel Sinks: Elkay, Just.


g. Sensor Faucets: Chicago Faucets, Symmons, Sloan, Mac Faucets.

h. Valves and Trim: T&S Brass, Dearborn Brass, Brasscraft, ProFlo, & Sloan.

i. Flush Valves: Sloan, Delany, Delta and Zurn, American Standard Selectronic, Kohler, Moen (sensor-operated only) & AMTC.

i. Carriers and Drainage Products: Jay R. Smith, Josam, Zurn, Wade, Watts, Neenah Foundry, NDS, & MIFAB.

j. Toilet Seats: Bemis, Church, Comfort Seats, Beneke, Zurn, American Standard, & Kohler.


m. Drinking Fountains/ Electric Water Coolers: Haws, Oasis, Stern Williams, Halsey Taylor, Elkay, Sunroc.


q. Service Sinks: Fiat, Acorn, Stern Williams, Zurn, Proflo, Mustee.
s. Backflow Preventers: Watts, Conbraco/Apollo, & Wilkins.
t. Hose Bibbs: Woodford, Josam, Zurn, J.R. Smith, Prier.
v. Utility Sinks: Fiat, Proflo, Mustee.

2. Plumbing Fixture Standards:

All plumbing fixtures shall meet or exceed the following standards:

a. ANSI A112.6.1 - Supports for Off-the Floor Plumbing Fixtures for Public Use.
b. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
d. ANSI A112.19.2 - Vitreous China Plumbing Fixtures.
e. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
f. ANSI A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
g. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
h. ANSI Z124.1 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Bathtub Units.
i. ANSI Z124.2 - Gel-Coated Glass-Fiber Reinforced Polyester Resin Shower Receptor and Shower Stall Units.

2. PLUMBING FIXTURES & TRIM:

A. All plumbing fixtures shall be provided complete with all required trim for a complete and operational system. All piping penetrations through finished walls shall be provided with chrome escutcheons. All plumbing fixtures shall be caulked and sealed to surrounding surfaces. All sink traps shall be provided with a cleanout plug in the bottom of the trap. All interior exposed pipe, valves, and fixture trim shall be chrome plated, including kitchen compartment sinks. Braided stainless steel pipe risers are approved for concealed locations only, such as behind casework doors or lav shields. Each fixture shall be provided with stop valves and the stop valves shall be quarter-turn brass ball type. All fixtures and trim must be lead free. All floor drains and floor sinks shall be provided with trap primers (PPP, Zurn or Wade as needed for appropriate use. Provide ball valve type shut-off valve upstream of all trap primer valves).
2.2 PIPING AND FITTINGS:

A. General:

1. Underground sanitary sewer and storm drain lines shall be installed at 1/4" per foot slope, unless otherwise indicated. If such slope is not possible due to existing inverts, approval shall be obtained from the Architect/Engineer and the authority having jurisdiction before any piping is installed at a lesser slope.

2. Connections between piping of dissimilar materials shall be made with dielectric waterway fittings or unions.

3. Provide standard manufactured water hammer arresters at all flush valves. Size and locate per manufacturers recommendations. Provide access panels for access to all water hammer arresters.

B. Domestic & Non Potable Hot and Cold Water:

1. Piping inside building above slab or above grade in crawl space shall be ASTM B88, Type "L", hard drawn copper. Fittings shall be ANSI/ASME B16.22 cast brass, or ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free.

2. Piping underground within 5 feet of the building line, smaller than 4 inches, shall be ASTM B88, Type "K", hard drawn copper. Piping below floor slab, smaller than 4 inches, shall be type "K", soft annealed copper. Fittings shall be ANSI/ASME B16.29 wrought copper. Joints shall be ANSI/ASTM B32 solder, Grade 95-5, lead free. No joints shall be installed beneath concrete floor slabs, unless approved by the Engineer. Underground or underslab copper piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
   a. Underground (below slab) Piping Option- ½" to 4", High Density Polyethylene (HDPE) pressure pipe. ASTM D3350, ASTM D3035 & ASTM F714. AWWA C901 & AWWAC906, NSF. Fittings shall be HDPE, solvent weld. Piping shall be rated for not less than 150 psig.
   b. Trap Primer Piping (below floor or concealed only) –
      1) ½" Wirsbo Aquapex Tubing or equal.

C. Sanitary Sewer and Vent:

1. Piping and fittings above grade shall be cast iron CISPI 301, ASTM A888 hubless, with cast iron fittings. Standard Couplings shall be neoprene gaskets and stainless steel clamp-and-shield assemblies and shall conform to CISPI 310, ASTM C 1277, FM 1680, & IGC-237, and be listed NSF International. Heavy Duty Couplings shall conform to ASTM C 1540. Pipe and fittings shall be manufactured by AB&I, Charlotte, Tyler, or receive prior approval.

2. Piping and fittings below grade shall be Schedule 40 PVC-DWV (cellular core), per ASTM F1488 and ASTM F891, solvent welded per solvent manufacturer’s instructions, or ABS Schedule 40 piping and fittings per either ASTM D2661 or ASTM F628 with solvent cement conforming to ASTM D2235. All sewer risers (2 story or more) shall be service weight cast iron, no-hub or single-hub, ASTM A74. All piping penetrations through fire rated walls, floors, or ceilings, and all piping located above ceilings used as return air plenums shall also be cast iron or galvanized steel, ASTM A53. Underground PVC-DWV piping shall be installed per ASTM D-2321.
3. Piping and fittings beyond 5 feet from the building line shall be PVC, ASTM D3033 or D3034, SDR 35. Joints shall be ASTM F477 with elastomeric gaskets. Underground piping shall be installed per ASTM D-2321.

4. All 90 degree waste line elbows shall be formed per the latest issue of the adopted plumbing code, latest edition.

5. All exposed vent piping located in occupied areas or rooms, is to be cast iron with cast iron fittings.

6. All flush valve fixtures that are installed back to back shall have offset waste outlet fittings.

7. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping which is more than 100 feet, and shall be provided for each 100 feet developed length, or fraction thereof of such piping. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred and thirty-five degrees, per applicable plumbing code. This shall be provided regardless of what is shown on the drawings.

8. All floor drains, floor sinks, and hub drains shall be installed with a trap primer.
   a. Flush Valve Primer: Trap primer shall be Precision plumbing products model FVP-1VB with vacuum breaker.
   b. Pressure Activated Primer: Trap primer shall be Precision plumbing products Model CPO-500 with DU distribution unit if required.

9. All vent's through roof (VTR’S) shall be extended at least 1 foot above the roof surface, or to the top of the closest adjacent parapet wall, whichever is greater.

D. Natural Gas:

1. Piping shall be Schedule 40 black steel pipe, ASTM A53. Exposed fittings 2 inches and smaller shall be ANSI/ASME B16.3, screwed, black malleable iron.

2. Fittings larger than 2 inches and all underground fittings shall be Schedule 40 steel butt-welded type. Underground piping shall be provided with a polyethylene jacket, ANSI/AWWA C105, or shall be wrapped with double layer, half-lapped, 10 mil polyethylene tape.
   a. Contractors Option for Underground Pipe:
      2) Piping and fittings underground and outside the building line may be JM Eagle UAC 2000 MDPE, medium-density polyethylene yellow gas pipe or an approved equal. Piping shall be installed in accordance with JM Eagle Publication JME-12B, “Polyethylene Yellow Gas Distribution Installation Guide.” JM Eagle’s UAC 2000 system can be joined by butt heat fusion, socket fusion, or saddle fusion. Installing contractor shall be licensed for fusion pipe installation of polyethylene pipe. ASTM D2513.

3. All exterior piping exposed to the weather shall be coated with a rust inhibitor – Rustoleum #866 Pro-Guard Primer – red or gray color – or approved equal.

E. Acid Waste and Vent- the following are approved piping alternatives: All others must be prior approved by the Engineer.

1. Below grade piping shall be ASTM D4101, schedule 40, non-flame retardant polypropylene acid waste and vent piping. Fittings shall be non-flame retardant polypropylene fittings and joined using electrofusion joint system. Above grade piping shall be ASTM D4101, schedule 40, flame retardant.
polypropylene acid waste and vent piping. Fittings shall be flame retardant polypropylene fittings and joined using electrofusion joint system. Piping for traps shall be glass acid waste piping. Connections between polypropylene and other piping materials shall be made using adapters according to manufacturer’s recommendations. Polypropylene piping and fittings installed above ceilings used as return air plenums shall be polyvinylidene fluoride (PVDF) ASTM E-84 and UL 723. Fittings shall be joined using electrofusion joint system. Piping and pipe fittings shall be installed in strict accordance with manufacturer’s recommendations. Underground piping shall be installed per ASTM D-2321. Installation and testing shall be in accordance with the contract drawings, the manufacturer’s recommendations and the local plumbing code. Manufactured by ORION, IPEX, Zurn Fusion Lock, Fuseal, or approved equal.

2. Cleanouts shall be provided at each horizontal drainage pipe, at its upper terminal, and each run of piping which is more than 100 feet, and shall be provided for each 100 feet developed length, or fraction thereof of such piping. An additional cleanout shall be provided for each aggregate horizontal change of direction exceeding one hundred thirty five degrees, per applicable code. This shall be provided regardless of what is shown on the drawings.

F. Condensate Drain Piping:

1. Exterior to building, or located in a plenum: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints. Copper piping shall not be used on 90% condensing type equipment.

2. Interior: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, or shall be Schedule 40 PVC. Copper piping shall not be used on 90% condensing type equipment.
   a. Inside Mechanical Rooms: Piping shall be Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, unless otherwise specified by the equipment manufacturer.

G. Hanger and Supports:

1. Pipe hangers shall be provided to adequately support all piping systems. Hangers shall be vertically adjustable to provide for proper pitch and drainage. Hangers shall allow for expansion and contraction of the piping system. Reference “General Regulations” of the latest edition of the adopted plumbing code, latest edition.

2. Hangers for pipe sizes 1/2 to 6 inches shall be adjustable clevis type, or unistrut saddles with all-thread hanger rod.

3. Hangers for hot pipe, sizes 6 inches and over shall be adjustable steel yoke, cast iron roll, double hanger type.


5. All insulated piping shall be provided with minimum 18 gauge galvanized insulation shields, 12 inches long, and oversized hangers. Pipe sizes 2 inches and over shall also be provided with 12 inch long calcium silicate insulating blocks between the piping and the galvanized insulation shield.
   a. Alternate: Insulated pipe support inserts may be provided at hanger, support, and guide locations on piping requiring insulation. The insert should consist of either Hydrous Calcium Silicate or Polyisocyanurate Foam insulation (Urethane) encircling the entire circumference of the pipe with a 360 deg. PVC (1.524 mm thick) or galvanized steel jacket and installed during the installation of the piping system. These insulated pipe support inserts shall be provided by the Mechanical Contractor and installed by the same during pipe support installation.
6. Hanger rod sizing and spacing for pipe shall be as follows:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Minimum Rod Diameter</th>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>To 1-1/4 inches</td>
<td>3/8 inch</td>
<td>6.5 feet</td>
</tr>
<tr>
<td>To 2 inches</td>
<td>3/8 inch</td>
<td>10 feet</td>
</tr>
<tr>
<td>To 3 inches</td>
<td>1/2 inch</td>
<td>10 feet</td>
</tr>
<tr>
<td>To 6 inches</td>
<td>5/8 inch</td>
<td>10 feet</td>
</tr>
<tr>
<td>8 to 12 inches</td>
<td>7/8 inch</td>
<td>12 feet</td>
</tr>
<tr>
<td>PVC &amp; ABS (all sizes)</td>
<td>3/8 inch</td>
<td>4 feet</td>
</tr>
<tr>
<td>Cast Iron No-Hub</td>
<td>5/8 inch</td>
<td>5 feet and at joints</td>
</tr>
</tbody>
</table>

7. Provide hangers within 12 inches of each horizontal elbow.

8. Provide hangers with minimum 1-1/2 inches vertical adjustment.

2.3 INSULATION:

A. General:

1. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

2. Fire-Test-Response Characteristics: Insulation and related materials NFPA 255, UL Classified per UL 723 or meeting ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement containers, with appropriate markings of applicable testing and inspecting agency.
   a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   b. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Piping:

1. All domestic, potable & non-potable, hot and cold water lines shall be insulated with preformed insulation.
   a. Fiberglass insulation with a vapor barrier jacket. Insulation shall have a conductivity not exceeding 0.28 Btu-inch/hour-sq. ft.-degrees F. Laps and butt joints shall be sealed with pressure sensitive joint sealing tape of the same finish as the insulation jacket to provide a continuous vapor seal. Fittings and valves shall be insulated with PVC fitting covers and fiberglass insulation inserts, or with hydraulic setting insulating cement and four ounce canvass jacket with vapor barrier adhesive.

   Insulation thicknesses shall be as follows:

<table>
<thead>
<tr>
<th>System</th>
<th>Pipe Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Cold Water (pot. &amp; non-pot.)</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

   Insulation thicknesses shall be as follows:

<table>
<thead>
<tr>
<th>System</th>
<th>Pipe Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Cold Water (pot. &amp; non-pot.)</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>
2. Insulation shall be installed in strict accordance with manufacturer’s instructions.

3. Insulation shall be continuous through penetrations.

4. All insulation shall be installed in a neat and workmanlike manner.

2.4 VALVES & STRAINERS:

A. Ball Valves:

1. Valves 2-inches and smaller shall be lead free cast bronze body, chrome-plated brass ball, teflon seats, and lever handle, 600 psi CWP. Valves shall comply with MSS SP-110, NSF/ANSI 61, NSF/ANSI 372 Lead Free. Valves over 2-inches shall be cast steel body, chrome plated steel ball, teflon seats, and lever handle. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint ball valves are acceptable if grooved piping is used. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain, wheel, and guides. Basis of design: Apollo #77CLF-A Series.

B. Butterfly Valve:

1. Valves 12-inches and smaller shall be ductile iron lug body, ASTM A-536, 316 stainless steel disc, EPDM Liner, 316 stainless steel stem, and safety twist-lock multi-position lever handle with open-closed lockout capabilities. Valve shall be rated at 175 psig WOG. Valves mounted higher than 7'-0" A.F.F. shall be provided with chain wheel and guides. Valves shall comply with MSS SP-67. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint butterfly valves are acceptable if grooved piping is used.

C. Check Valves:

1. Valves 2-inches and smaller shall be bronze body Y-pattern, ASTM B-62, swing check, bronze disc, 200 psi WOG. Valves shall comply with MSS SP-80, NSF/ANSI 61-8 F&B, NSF/ANSI 372 Lead Free. Valves, over 2-inches shall be iron body, ASTM A-126, bronze trim, swing check, renewable disc and seat. Valves shall comply with MSS SP-71. Victaulic, Anvil Gruvlok, Grinnell, or Shurlock check valves are acceptable if grooved piping is used. Basis of design: Apollo # 161T-LF/161S-LF Lead Free Bronze, Apollo # 920F-LF Lead Free Cast Iron.

2. Swing check valves with outside lever and spring (not center guided) is to be used on sewage ejector or storm-water sump pumps. Basis of design: Apollo # 910FLW-LF Lead Free Cast Iron.

D. Pressure Reducing Valves:

1. Valves 2-inches and smaller shall be bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, and single union end. Basis of design: Apollo # 36ELF Series Lead Free Bronze.

E. Balance Valve:

1. Valve shall have a twin tube 316 S.S. design with blowout proof attachment to station body. Ports shall include ¼" port for thermometer, ¼" port for pressure gauge, air vent, and ½" drain port.

2. The instrument station shall be 120/150-flanged construction.
3. The butterfly valve shall be lug pattern with a rating of 200 WP, 250 deg. F. The valve shall have an infinite. Position operator with memory stop (6” and smaller), worm gear with memory stop (8” and larger).

F. Strainers:

1. Strainers shall be cast steel body, Y-pattern, 20-mesh stainless screen. Victaulic, Anvil Gruvlok, Grinnell, or Shurjoint strainers are acceptable if grooved piping is used.

PART 3 - EXECUTION

3.1 WORKMANSHIP:

A. General:

1. Install all piping, fixtures, equipment, and accessories as shown, and in strict accordance with the plumbing laws, rules, and regulations of the State and/or City. All work shall be done in a neat and orderly fashion, and left in a condition satisfactory to the Architect/Engineer.

B. Piping:

1. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to allow for expansion. Waste and vent piping occurring above floor slab shall be installed true and plumb. Extend vents at least 1 foot above roof, or to the top of the closest adjacent parapet wall, whichever is greater, and provide watertight flashing sleeves. Excavation and backfill shall be in accordance with Section 220000 of these specifications.

C. Fixtures:

1. Install fixtures true and plumb with building walls. Caulk all plumbing fixtures at joints along walls, countertops, and other intersecting surfaces. Locate fixtures as shown and per manufacturer’s instructions. Furnish all required trim for fixtures to provide a complete and workable installation.

3.2 TESTS:

A. General:

1. All piping, fixtures, and equipment shall be inspected and approved before concealing or covering. All work shall be tested as required by Section 220000 of these specifications, and shall be leak proof before inspection is requested. All tests shall be repeated if required by those making the inspection.

2. All potable water systems shall be flushed and disinfected in accordance with Section 220000 of these specifications. Following disinfection, system shall be flushed and water sampled to show compliance with requirements of public health authority having jurisdiction. If tested water does not meet requirements, disinfecting shall be repeated until water quality meets requirements.

3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gasket shall be molded and produced by Victaulic Company, Gruvlok, or Grinnell Mechanical Products, or equal. Verify gasket grade is suitable for the intended service. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for
contractor’s field personnel the use of grooving tools, application of groove, and installation of grooved end products.

a. All grooved joint couplings, fittings, valves and specialties shall be the products of Victaulic Company, Gruvlok, Grinnell Mechanical Products, or equal.

4. Install the grooved piping in accordance with the latest recommendations as published by the manufacturer. Pipe shall be square cut, +/-0.30", properly deburred and cleaned. Mark pipe ends at the required location using a gauge supplied by the manufacturer to ensure full insertion into the coupling or fitting during assembly. Use a manufacturer’s tool with the proper sized jaw for pressing.

B. Fixtures and Equipment:

1. Fill all plumbing fixtures with water and check for leaks or retarded flow. Repair as required. Adjust each piece of plumbing equipment as required to insure proper functioning. Leave all fixtures and equipment in first class operating condition.

2. The Plumbing Contractor is responsible for all backflow devices to be inspected by a certified backflow technician before use of the building potable water system.

C. Smoke Test:

1. A smoke test shall be performed on the entire waste and vent system before building occupancy. After all fixtures are permanently connected and traps are filled with water, fill entire drainage systems with smoke under pressure of 1.3 pKa (1 inch of water) with a smoke machine. If leaks are detected, they shall be repaired and the smoke test shall be performed again until no leaks are found.
PIPING SYSTEM TEST REPORT

STRUCTURE/BUILDING: Renaissance High School
LOCATION: Meridian, Idaho

DESCRIPTION OF SYSTEM/PIPING BEING TESTED:

<table>
<thead>
<tr>
<th>Description of Test Performed</th>
<th>Test Pressure</th>
<th>Test Duration</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrostatic:</td>
<td>P.S.I.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inert Gas:</td>
<td>P.S.I.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressed Air:</td>
<td>P.S.I.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste &amp; Vent Smoke Test:</td>
<td>1&quot; Water Column</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NAME AND TITLE OF PERSON IN CHARGE OF PERFORMING TEST'S FOR CONTRACTOR:

Name: ___________________________ Title: ___________________________
Signature: _______________________

I hereby certify that the above described system has been tested as indicated above and found to be entirely satisfactory as required in the contract specifications.

Signature of Inspector: ___________________________ Date: ___________________________

REMARKS:

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

END OF SECTION 220100
DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

SECTION 230000 - HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE:

A. General:

1. The Bidding Requirements, Contract Requirements, and the General Requirements (Division 1) of these specifications shall govern all parts of the work.

B. Work Included:

1. Install work in accordance with these specifications and the accompanying plans. Furnish all labor, material, and equipment together with all incidental items not specifically shown or specified which are required by good practice to provide the complete mechanical systems as described.

2. The HVAC Contractor(s) and all Sub-tier Contractors shall provide installed equipment cut sheets and purchase orders required for utility rebates.

C. Coordination and Site Visits:

1. This section of the work requires examination of and reference to all architectural, structural, utility, and electrical drawings for construction conditions that may affect the work. Inspect the building site and existing facilities for verification of existing conditions. Base all measurements from established benchmarks. Any discrepancy between actual measurements and those indicated, which prevents following good practices or the intent of the drawings and specifications, shall be reported to the Architect/Engineer, and work halted until instructions are received from the Architect/Engineer.

1.2 CODES, PERMITS, FEES:

A. Install all work in accordance with applicable codes and standards. Obtain all required permits; pay all required fees including utility connections or extensions, in connection with this portion of the construction. Obtain all required certificates of inspection for the work.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP:

A. Materials:

1. All materials and equipment shall be of first quality, new, full size and weight, standard in every respect, and suitable for the space required. Use the same manufacturer for products of similar class or service, such as valves, pumps, controls, and air handlers. Protect all materials against loss, theft, or damage before and after installation.
2. Furnish equipment that will operate under all conditions of load without any sound or vibration that is objectionable in the opinion of the Architect/Engineer. Vibration or noise considered objectionable will be corrected by the Subcontractor at his expense.

3. Furnish and install all necessary foundations, supports, pads, bases, and piers required for all materials and equipment furnished under this contract.

4. Provide all required firestopping at duct penetrations of fire rated walls, floors, ceilings, and roofs. Firestopping shall be Dow Corning Fire Stop Sealant 2000 or Fire Stop Foam 2001, or approved equal.

B. Workmanship:

1. All materials and equipment shall be installed in a neat and workmanlike manner by competent specialists for each subtrade. Work shall be installed to the satisfaction of the Architect/Engineer with unsatisfactory work removed and reinstalled to his satisfaction at no extra cost to the Owner.

2. Provide all cutting and patching necessary to install the work specified in this section. Patching shall match adjacent surfaces. No structural members shall be cut without the approval of the Architect/Engineer. Provide sleeves at all piping penetrations of exterior walls and floors on grade. Provide all sleeves and inserts required before new floors and walls are built.

3. Locate all equipment that must be serviced in fully accessible positions. Provide clearance for removal of replacement parts and components, and with necessary couplings or flanges to remove the component for maintenance.

C. Protection of Equipment During Construction:

1. At the end of each shift, all duct openings and open ends shall be covered with a plastic poly sheeting film to protect against dust and construction contamination from entering the ductwork.

2.2 SUBMITTALS AND SUBSTITUTIONS:

A. Prebid Approval:

1. Manufacturer’s trade names and catalog numbers stated herein are intended to indicate the quality of equipment or materials desired. All manufacturers not specifically listed require prior approval. Submit catalog data, including specifications, of the proposed equipment to the Architect/Engineer for his approval at least 10 calendar days prior to bid opening. Notice of such approvals will be published in an addendum. Approval of listed alternate equipment manufacturers is for bidding only. Final approval is to be based on requirements of the plans and specifications.

B. Submittals:

1. Within thirty days after award of this contract, provide six copies of a complete list of all materials and equipment proposed for this project. List shall contain make, type, manufacturer’s name, and trade designation of all materials and equipment. Submittal shall also include manufacturer’s complete specification for each item, including capacities, ratings, etc., and dimensions as required to check space requirements. Provide six copies of all submittals. The scheduled equipment is the basis of design for capacity, weights, physical size, etc. Alternate manufacturers shall not exceed the weight or physical size. Any changes to the Architectural, Structural, Mechanical, Electrical, and Control systems due to alternate manufactures shall be the responsibility of the Contractor and Supplier.
Submittals for each major trade (i.e., dryside HVAC, wetside HVAC, or Plumbing) shall be submitted in a single complete package. Individual items will not be reviewed independently unless approved by the Engineer. Electronic submittals will be allowed when approved by the Architect and, or Owner. The requirements of electronic submittals are the same as those noted above.

2. Approval of submittals shall not relieve the contractor from responsibility for deviations from the plans or specifications, unless he has, in writing, called the Architect's /Engineer's attention to deviations at the time of submission, and obtained his written approval. Approval of submittals does not relieve the contractor from responsibility for errors in shop drawings or literature.

C. Equipment Requiring Submittals:
   1. Water Source Heat Pumps
   2. Energy Recovery Unit
   3. Packaged Rooftop Units
   4. Exhaust Fans
   5. Ductless Split System
   6. Pipe Stands
   7. Flex Duct
   8. Grilles / Diffusers

PART 3 - EXECUTION

3.1 ACCESSIBILITY & SAFETY:
   A. Accessibility:
      1. All equipment which must be serviced or operated shall be located in fully accessible position. Minor changes from the drawings may be made to allow for better accessibility. All changes shall be approved prior to actual installation.

      2. Access panels shall be provided if required for accessibility. Access panels to be steel, flanged, hinged doors by Cendrex, or equal. Sized as required for installation. Subcontractor shall furnish the required panels to the General Contractor and the required location for all access panels, unless otherwise specified in the Architectural specifications. Panels shall be installed by the General Contractor.

   B. Safety:
      1. Subcontractor shall provide guards for all belt drives and rotating machinery.

3.2 COORDINATION:
A. Coordinate all work with the various trades involved to provide a complete and satisfactory installation. The exact details of ductwork and equipment are not shown. No additional compensation will be made for offsets or relocation required in coordination with other trades.

B. Alterations required due to improper supervision by the subcontractor shall be made at no extra cost, to the satisfaction of the Architect/Engineer.

3.3 ELECTRICAL:

A. Electric motors required for equipment specified in this section shall be provided and installed by this Subcontractor. Motor starters, disconnects, relays, pilot lights, etc., are in general, to be furnished and installed by the Electrical Contractor. Starters, relays, controls, etc., which are factory assembled into packaged equipment shall be furnished by the Mechanical Contractor under this section of the specifications.

B. All motors shall be provided with adequate starting and protective equipment as specified or required. Motor capacity shall be sufficient to operate driven device under all conditions of operation and load without overload. Minimum horsepower shall be as specified.

3.4 IDENTIFICATION AND CODING:

A. Painting:

i. All painting of mechanical equipment, accessories and ductwork shall be furnished and applied under the Architectural section of these specifications. All painting shall be completed before any identification markings are applied.

B. Equipment:

i. Identify all equipment with a black Formica label, with white reveal when engraved. Lettering to be 3/16 inch high minimum. In general, identify equipment as to area served in addition to title and code number of the equipment as taken from the plans.

C. Piping:

i. Identify all piping as to the service of the pipe and the direction of flow. The letters shall be 3/4 inch high on piping two inches or smaller, and 1-1/4 inches high on piping up to six inches. Flow arrows shall be at least six inches long. The letters and flow arrows shall be made by precut stencils and oil base paint, one inch high and black, or factory fabricated plastic pipe markers. Piping shall be identified at 25 foot maximum intervals, on long continuous lines; adjacent to each item of equipment; on each riser and junction, and on both sides of all wall penetrations. Underground piping shall be identified with bright colored continuously printed plastic tape of not less than 6" wide by 4 mil thick, manufactured for direct burial service. Install directly above all buried pipe, 6 to 8 inches below finished grade.

3.5 TESTING:

A. Systems:

i. All systems, including heating, ventilating and air conditioning, shall be tested at the completion of the building to establish that the systems operate as specified and required. Testing shall be performed
after air balancing is completed.

2. All controls shall be calibrated accurately and all equipment shall be adjusted for satisfactory operation. Excessive vibration or noise from any system shall be corrected.

3. The air conditioning system shall be tested for satisfactory operation when the outside air temperature reaches 60 degrees F. or warmer. All other systems shall be tested at building completion. All tests shall be performed in the presence of the Architect/Engineer or his representative.

3.6 BALANCING:

A. Scope:

1. Prior to final acceptance by the Owners, all air and water systems shall be balanced to deliver the quantities as specified or directed. The air and water balance shall be performed by an independent agency specializing in balancing and is certified by the National Environmental Balancing Bureau.

2. Balance contractor's main office shall be located within 50 miles from the project site. Approved balance contractors are Felts-House Engineering, Ro-Bar Technical Services, and Building Systems Technologies. All other contractors must receive prior approval from the Engineer, in writing, before bidding the project.

3. The Mechanical Contractor shall provide assistance to the Balancing Contractor by identifying all installed mechanical systems and assisting access to all installed mechanical systems. All mechanical systems shall be completely operational and functional prior to the Balancing Contractor performing their specified work.

B. Air balancing:

1. Balancing of the air system shall consist of:
   a. Adjust all air volumes to the quantities shown, with allowable variation of plus 10, minus 10 percent.
   b. Record all system, zone, diffuser, grille, and register C.F.M. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Balancing Engineer shall work with the Contractor to set minimum & maximum CFM quantities for zone dampers, or zone dampers/heaters.
   c. Test and record all system static pressures, inlet and discharge, on all packaged units, fans, and terminal units. Vary total system air quantities by adjustment of fan speeds. Provide drive changes as necessary. Vary branch air quantities by damper regulation.
   d. Test and record motor full load amps and nameplate amps.
   e. Test and record entering and leaving temperatures at all coils.
   f. Adjust all automatically operated dampers, in cooperation with the Control Contractor, to the required settings. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances. Where modulating dampers or economizers are provided, take measurements at full return air, minimum outside air, and 100 percent outside air mode of operation.
   g. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and excessive noise where possible.
   h. Mark final positions of all balance dampers with a red felt pen.
   i. Air systems shall be balanced in accordance with standard procedures and recognized practices of the Associated Air Balance Council, and the Testing Adjusting, and Balancing...
C. Water Balancing:
   1. Balancing of the water system shall consist of:
      a. Adjust all heating and cooling water system flows to within 10 percent of the design quantities shown.
      b. Record all system and terminal unit g.p.m.'s.
      c. Test and record all pump, coil, boiler, heat transfer elements, and chiller entering and leaving water temperatures and pressures.
      d. Test and record all pump full load amps and nameplate amps.
      e. Mark all final positions of all balancing cocks, valves, and operators with a centerpunch.

D. Quality Assurance:
   1. The Balancing Contractor shall demonstrate to the Engineer of record, flow verification for at least 10% of the balanced devices as selected by the Engineer. If more than 25% of the tested devices do not meet the designed or balance report, then the entire system balance must be rebalanced.

E. Balance Reports:
   1. Submit four copies of the air and water system balance reports to the Architect/Engineer for evaluation and approval. Reports shall be on TABB/SMACNA forms that indicate information addressing each of the testing methods, readings, and adjustments.

3.7 CLEANING AND ADJUSTING:
A. Thoroughly clean all air conditioning units, air handling units, and all associated parts of the system at the completion of the work. Install new, clean air filters in all systems. Adjust all devices for proper operation and lubricate all equipment as required. Repaint any painted surface that has been damaged.

3.8 PROJECT CLOSEOUT:
A. Operations & Maintenance Manual:
The Contractor shall provide an operations and maintenance manual at least thirty days prior to completion of work. The manual shall be of the three ring binder type, entitled "Operations and Maintenance Manual", with the job name and year of completion also included. O & M manuals shall be submitted in a single package. Individual items will not be accepted independently unless approved by the Engineer. The manual shall include, as a minimum:
   1. Maintenance instructions for all equipment, including lubrication requirements.
   2. Equipment supplier's names, addresses, and telephone numbers.
   3. Equipment catalog cuts, ratings tables, model numbers, serial numbers, and accessories.
   4. Parts numbers for all replaceable parts.
   5. Air and water systems balance report as hereinbefore specified.
   6. Control diagram or drawing and operation sequence.
7. Valve tagging chart as hereinbefore specified.

8. Filter chart listing unit callout, size of filters, and quantity of filters.

9. Guarantee letter as specified below.

10. Any additional information required to enable the Owner to properly maintain the building mechanical system.

11. Mechanical Equipment Start-up forms, which are included in this specification, if they are required.

12. After approval of the Operations and Maintenance Manual by the Architect/Engineer, the Contractor shall furnish two copies of the manual to the Owner.

**B. Mechanical System Training Period:**

1. After the mechanical system is completely installed and operational, the mechanical contractor shall provide a minimum of 4 hours training and instruction time for the building Owner or his representative. During this period, the contractor shall instruct the Owner in the operation and maintenance of all parts of the mechanical system, using the O & M manual where applicable. The contractor shall provide a copy of the Project Owner Mechanical Systems Training Form (attached to this specification), with proper signatures, to the Engineer prior to substantial completion and insure that a copy is inserted into the project O & M manuals.

2. Video Taping – The mechanical contractor is to perform videotaping of the Owner training and instruction. Provide two (2) CD copies to Owner and one (1) copy to be inserted into the O & M Manuals.

**C. As-Built-Drawings:**

1. Provide two sets of blue-line mechanical drawings showing the work as it was actually installed. The drawings shall indicate all departures from the contract drawings. Make all notations neat and legible, with red indelible pencil. At the completion of the work, these as-built drawings shall be signed and dated by the Mechanical Contractor, and returned to the Architect/Engineer.

**D. Guarantee:**

1. All work furnished under this section shall be guaranteed in writing to be free from defective work or materials for a period of one year after acceptance of the contract. All repairs or replacements because of defective materials or workmanship or noncompliance with code shall be provided without additional cost to the Owner. Contractor shall furnish a letter indicating above guarantee with space for date of acceptance and expiration of guarantee. Letter shall be included in O & M Manual.

**END OF SECTION 230000**
NAME OF PROJECT:

________________________________________

OWNER MECHANICAL SYSTEM TRAINING FORM

Upon completion of the equipment and systems installation and connections, the contractor shall assemble all required equipment factory representative and subcontractors together for system Owner training.

These people shall assist in Owner training their system(s) and remain at the site until the total system operations is acceptable and understood by the Owner’s representative(s), maintenance and/or operation personnel, on operation and maintenance of their equipment. To prove acceptance of operation and instruction by the Owner’s representative(s), the contractor shall provide a copy of this form, with proper signatures, to the Engineer prior to substantial completion, and insure that a copy is inserted into the project Operation and Maintenance manuals.

“I, the Contractor, associated factory representative and subcontractors, have started each system and the total system(s); and have proven their normal operation to the Owner’s representative(s) and maintenance/operation personnel and have instructed him/them ____________, hours in the operation and maintenance thereof.”

__________________________________   ______________ __________________
Owner’s Representative    Contractor

__________________________________   ______________ __________________
Signature      Signature

________________________    _______________________
Date      Date
SECTION 230100 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the work necessary for the heating, ventilating, and air conditioning system, complete. The HVAC General Requirements, Section 230000, is to be included as a part of this section of the specifications.

1.2 CODES & STANDARDS

A. The heating, ventilating, and air conditioning system shall be installed in accordance with the latest edition of the following codes and standards:

1. International Mechanical Code (IMC)
2. International Building Code (IBC)
3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
4. National Fire Protection Association (NFPA)
5. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS AND APPURTENANCES

A. Energy Recovery Ventilator (Plate Type):

1. General:
   a. Unit manufacturer shall have a minimum of 20 years experience in the heat recovery market.
   b. The system shall deliver the specified air volume at the static pressure scheduled.
   c. The unit shall be constructed to provide smooth interior surfaces and to limit the casing leakage at less than 1% of the specified air volume at operating static.
   d. Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the ETL label of approval.
   e. Unit shall be constructed in accordance with industrial design practices.
   f. Insulation shall comply with NFPA 90 A requirements for flame spread and smoke generation.
   g. Air flow data shall comply with AMCA 210 method of testing.
   h. Cabinet and exterior components shall be tested and certified weatherproof.
   i. All units shall be 100% factory tested.
   j. All effectiveness data of heat and energy recovery components shall be certified by the ARI 1060 certification program directory.
   k. Unit shall be stored and handled per manufacturer’s recommendations. See manufacturer installation procedures, maintenance and operation manuals for an adequate installation. Manufacturer is not responsible for any damage done to the unit caused by poor rigging or
installation operation.

1. Unit outside air intake hood shall not be installed in front of the prevailing winds.

2. Equipment:
   a. Factory assembled, consisting of fan and motor assemblies (supply and exhaust), heat recovery device (flat plate heat exchanger), all necessary dampers, plenums, filters, drain pans, wiring and controls. Unit shall be stand-alone controlled with all control devices provided by the unit manufacturer. Unit shall have single point power connection.
   b. Unit Cabinet:
      1) All unit panels are fixed with zinc plated hexagonal head type screws complete with a washer and rubber gasket for a weatherproof assembly. Self-drilling, self-tapping screws are used and therefore no tools are required for panel removal. These panels allow for fast service to all major components.
      2) All panel joints must be caulked with a weatherproof silicone. The silicone used must be clear to match any color surfaces. After application, the silicone must react with atmospheric moisture to produce a formed-in-place silicone rubber glazing and curtain wall seal.
      3) Unit base frame shall be constructed from a 6” [152mm] formed steel rail with internal structural cross members properly sized to allow rigging and handling of the unit. Unit base frame shall be internally insulated with 4” [102mm] R12 fiberglass insulation.
      4) Unit floor shall be double wall construction. Floor shall accommodate for curb or concrete pad installation. Single wall floor construction and non-insulated floor shall not be acceptable.
      5) Unit construction consists of an insulated heavy gauge galvanized structural frame complete with die cast aluminum corners. Roof and wall panels shall be double wall construction using 2” thick mineral wool insulation, heavy gauge galvanized steel exterior panels and medium gauge galvanized steel inner liner. The unit shall be designed to resist any snow, ice and wind loads, as well as seismic loads in compliance with the National Building Code. Single wall construction with coated insulation will not be acceptable. Exposed insulation edges in the airstream will not be acceptable.
      6) The unit shall include intake and exhaust hoods with birdscreens.
      7) Full size access door(s) to allow for periodic maintenance and inspections must be provided for all serviceable components. Doors shall be double wall construction made of heavy gauge galvanized steel on both outer and inner door liner. Doors shall be complete with heavy-duty hinges and compression type handles.
      8) Units shall be painted with primer and two coats of enamel paint.
   c. Internal Protection:
      1) Unit cabinet shall have a corrosion resistant liner (heresite paint) to provide a readily cleanable surface and to protect interior wall from degradation.
      2) The unit cabinet and all internal components exposed to pool air shall be designed to withstand the effects of high-humidity and corrosive chemicals commonly found in a pool environment. Inner liner shall consist of a corrosion-resistant phenolic coating.
      3) Blowers shall be epoxy coated and all high voltage wiring shall be enclosed in liquid-tight conduit. Where condensation may occur on the heat exchanger, drain pan(s) shall be fabricated out of stainless steel and shall be IAQ type.
   d. Heat Exchanger and Defrost Strategies:
      1) Flat plate heat exchanger shall be certified to AHRI Standards 1060 and tested in accordance with ASHRAE 84-91.
      2) Flat plate heat exchanger shall be cross flow type made of 6 mil embossed pure aluminum designed to maximize efficiency and minimize pressure loss.
      3) The flat plate heat exchanger shall be a UL recognized component and shall be manufactured under ISO 9001-2000 certified quality procedures.
      4) Access to all four sides for cleaning shall be provided.
5) An access section with sloped drain pan shall be provided upstream and downstream of heat exchanger for service and collection of condensate and cleaning.
6) The defrost system shall close the outside air damper upon activation of an internal temperature sensor and the exhaust fan will shut-off. Air will then re-circulate within the energy recovery unit across the energy recovery unit's flat plate heat exchanger until defrost is achieved. The energy recovery unit will then continue normal operation. All controls for the defrost system shall be internal and the defrost system will only operate when the outside air drops below a predetermined temperature.

e. Fans:
   1) The fan performance ratings shall be factory tested and comply with AMCA 210.
   2) All fans shall be statically balanced and designed in accordance with ANCA 300.
   3) All fans shall be centrifugal type with reinforcement and support to prevent vibration and pulsation.
   4) Each fan shall be mounted on 1 inch (min) deflection spring isolators and neoprene flexible connections.
   5) Fans shall be sized for stable operation at least 20% under the first critical speed.
   6) Units shall be equipped with non-overloading, airfoil, DWDI fans to provided scheduled air flows at pressure indicated. Fans shall be centered in air stream.
   7) Fan shafts shall be of solid steel, ground and polished with corrosion protection finish.
   8) Bearings shall be heavy duty type, grease-lubricated, self aligning pillow block type.
   9) Fan drives shall be designed for a 1.4 service factor.

f. Motors:
   1) All motors shall be internal to the unit and mounted on adjustable bases.
   2) Fan motors shall be heavy duty, TEFC type, premium efficiency, open drip proof, NEMA Design B with Class F insulation and 1.15 service factor. Motors shall be constant speed and rated for voltage as indicated on schedule.
   3) Motor sizes shall be min so that the drive load will not require motor to operate in service factor.
   4) Temperature rating shall be 122F maximum temperature at 104F ambient to continuous duty at full load.

F. Filters:
   1) Filters shall be UL 900 Class II.
   2) Both outside and inlet air streams shall be filtered.
   3) Filter banks shall be arranged for easy maintenance.
   4) Air velocity shall not exceed 500 FPM through each filter bank.
   5) Unit shall include 2 inch disposable filters, 25 – 30% efficiency.
   6) Contractor shall provide 4 sets of additional filters for owner’s stock at the completion of the project.

h. Dampers:
   1) Air leakage shall not exceed 10.3 cfm/sq. ft.
   2) Dampers shall operate in temperature range 140F to 212F.
   3) Unit shall be equipped with all necessary dampers and damper operators, including defrost damper systems.
   4) All dampers shall be motorized.
   5) Dampers shall be of aluminum with neoprene edges with top and bottom seals.

i. Electrical Components:
   1) All electrical controls shall be ETL listed and in accordance with the National electrical code standards.
   2) The unit will be equipped with a non-fused disconnect switch and a single point power connection. All internal wiring shall be by the factory.
   3) Unit shall be equipped with all necessary internal electrical components such as the following:
      All necessary motor starters
Thermal protection on all motors
Fuses and fuse holders
All necessary control transformers

4) Unit shall be equipped with all necessary switches and contactors.
5) Automatic start-up shall be provided as standard via an external dry contract, provided by and connected by the DDC contractor.
6) All fan access doors shall be provided with power interruption switches for fan shutdown in case of open access door.
7) Unit shall be supplied with low voltage remote wall mounted control panel to be located inside attic space next to each respective unit complete with hand/off/auto switch and indicator lights.

j. Controls:
1) All electrical controls shall be ETL listed and the entire unit shall be factory wired in accordance with the National Electrical Code Standard.
2) Unit shall be equipped with all necessary high voltage components as follows:
   a) Motor starters on all high voltage motors for constant speed applications.
   b) Thermal protection on all high voltage motors.
   c) Fuses and fuse holders.
   d) All necessary control transformers.
3) The automatic unit start-up is provided as standard via an external dry contract provided by others (ex) building management system, DDC controller, time clock, etc.
4) Terminal board shall be provided for low voltage control wiring. Low voltage is 24V.

k. Warranty:
1) Manufacturer shall warrant the unit against manufacturing and material defects in accordance with the Division 1 requirements of this contract and also as noted below, whichever is more restrictive:
   All parts except heat exchanger media – Two (2) years
   Flat plate heat exchanger – Fifteen (15) years

3. Capacity, Manufacturer, and Accessories:
   a. See drawings.

B. Water to Air Heat Pump:

1. General:
   a. Packaged heat pump shall consist of compressor, water cooled condenser, evaporator coil and fan, filter, refrigerant piping and specialties, and controls, all contained in a sound insulated cabinet. Entire unit shall carry the UL label and shall be tested in accordance with ARI standard 13256-1 for efficiency, and ARI-260 for sound requirements.

2. Cabinet:
   a. Cabinet shall be of heavy gauge welded steel construction with a baked enamel finish. Cabinet shall be internally insulated with sound attenuating insulation. All insulation exposed to the airstream shall be moisture resistant. Cabinet shall contain externally stubbed water and drain connections, access panels for inspection or maintenance on all internal components, and duct collars for supply and return air duct connections. Filter rack shall be incorporated into the cabinet for installation of throw-away filters. Cabinet shall contain threaded fasteners or hanger attachments for ceiling suspended units.

3. Compressor:
   a. Compressor shall be a hermetically sealed scroll-type compressor, and be internally vibration isolated. Compressor shall be provided with internal overload protection, high and low pressure cutouts, and a lock-out relay to provide a manual reset of safety controls at the
thermostat. Compressor shall carry a 5 year guarantee.

4. Blower and Motor:
   a. Blower shall be of the centrifugal type, dynamically balanced to eliminate vibration. Fan motors shall be high-efficiency type, and be furnished with internal overload protection.

5. Heat Exchangers:
   a. The air-to-refrigerant heat exchanger shall consist of a staggered copper tube with aluminum fins. The refrigerant-to-water heat exchanger shall be of the coaxial, tube-in-tube type, with the inner tube being rifled or convoluted copper and the outer tube (or shell) of primed and painted steel. Heat exchangers shall be designed for a minimum working pressure of 200 psi.

6. Controls:
   a. Heat pump controls shall be microprocessor based. Heat pump controls shall include the following safety & control features:
      1. Short cycling protection
      2. Startup control protection
      3. Brownout protection
      4. Emergency shutdown
      5. Condensate overflow protection
      6. High Pressure and Low Temperature Protection
      7. Low Refrigerant pressure shutdown
      8. Manual reset at thermostat or disconnect.

7. Refrigeration Circuit:
   a. Units shall include a sealed R-410A refrigerant circuit including compressor, thermal expansion valve metering device, heat exchangers, reversing valve, liquid refrigerant filter/dryer and service ports.

8. Filters:
   a. Filters shall be 2" thick replaceable pleated media type, rated at MERV 8. Provide 4 extra sets of filters per unit.

9. Manufacturer, Capacity & Accessories:
   a. See drawings.

C. Packaged Rooftop Air Conditioning Unit:

1. General:
   a. The packaged unit shall consist of condensing section, evaporator section, heating section, blower, filter, and controls, all contained in weatherproof casing suitable for installation on the roof. The entire unit is to be factory wired, piped, and tested. Unit shall bear the UL label for the intended application.

2. Casing:
   a. Casing shall consist of welded steel reinforced framework with 18-gauge zinc grip steel finished with weatherproof baked enamel paint. Cooling section shall be insulated with minimum 1" thick, 1.5 density coated sound absorbing insulation. Easily removable panels shall be provided for access to internal components.

3. Condensing Section:
a. Condensing section shall include spring mounted hermetic compressors; air cooled condenser and fans, evaporator coil, and refrigeration piping and specialties. Compressors shall be furnished with current and temperature overload protection, oil sight glass, and shall carry a 5-year guarantee. Condenser fans shall be upflow propeller type with direct or belt drive motors with overload protection. Propeller fans shall be coated with weather resistant finish and protected by fan guard. Evaporator coils shall be direct expansion coils complete with thermostatic expansion valves. Furnish galvanized drain under coil. Refrigerant piping system shall be completely factory piped with a full operating charge of R-410a. Suction line to be insulated. Units shall be furnished with low ambient control, for operation down to 0 degrees F (not required on units furnished with economizers).

4. Gas Heating Section:
   a. Gas heating section shall be AGA certified and include gas fired furnace with steel heat exchanger and burners, power vent, manual main and pilot shutoff valves, automatic gas valve, electronic ignition, and flame proving controls. Entire unit shall be tested and certified for operation down to -30 degrees F outdoor temperature.

5. Blower:
   a. Blower section shall consist of heavy duty, centrifugal blower wheels, balanced to eliminate vibration. Furnish adjustable motor mount and v-belt drive. Motors shall be furnished with overload protection.

6. Filters:
   a. Filters for units 2 ½ tons or smaller shall be 1 inch thick replaceable pleated media type, rated at MERV 8.
   b. Filters for units 3 ton and above shall be 2 inch thick replaceable pleated media type, rated at MERV 8. Provide with 2 inch filter rack.
   c. Provide 4 extra sets of filters per unit.

7. Control Section:
   a. Controls shall include a factory installed control circuit transformer, starters, 3-leg overload protection, high and low pressure refrigerant controls, and terminal strip for connection of remote controls.

8. Manufacturer, Capacity and Accessories:
   a. See drawings.

2.2 REFRIGERATION

A. Ductless Split System - Wall-Mounted Units

1. General:
   a. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall mounting bracket and mounting hardware. Unit shall be rated per ARI Standards 210/240 and UL labeled.

2. Unit Cabinet:
   a. Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.

3. Fans:
a. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
b. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.

4. Coil:
a. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.

5. Motors:
a. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

6. Controls:
a. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 62° F to 84° F.
b. The unit shall have the following functions as a minimum:
   1) An automatic restart after power failure at the same operating conditions as at failure.
   2) A timer function, to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
   3) Temperature-sensing controls shall sense return air temperature.
   4) Indoor coil freeze protection.
   5) Wireless infrared remote control to enter set points and operating conditions.
   6) Automatic air sweep control to provide on or off activation of air sweep louvers.
   7) Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
   8) Fan-only operation to provide room air circulation when no cooling is required.
   9) Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
   10) Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.
   11) Automatic heating-to-cooling changeover in heat pump mode. Control shall include deadband to prevent rapid mode cycling between heating and cooling.
   12) Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.

7. Filters:
a. Unit shall have filter track with factory-supplied cleanable filters.

8. Electrical Requirements:
a. Power is supplied from outdoor unit.

9. Special Features (Field Installed, if necessary):
a. Condensate Pump: The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts; an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. A liquid level sensor in the reservoir shall stop cooling operation if the liquid level in the reservoir is unacceptable.
Warranty:

- Minimum 1 year parts limited warranty.

Outdoor Units:

- ¼ to 3 Ton Nominal Cooling Capacity / ¼ to 3 Ton Nominal Heating Capacity

General:

1) Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the compressor.

2) Units shall consist of a rotary compressor, an air-cooled coil, propeller-type draw-through outdoor fan, reversing valve (HP), accumulator (HP units), metering device(s), and control box. Units shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to-air cooling only, or heat pump system.

3) Units shall be used in a refrigeration circuit matched to duct-free cooling only or heat pump fan coil units.

Unit Cabinet:

1) Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish on inside and outside.

2) Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.

3) Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.

Fans:

1) Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall draw air through the outdoor coil.

2) Outdoor fan motors shall be totally-enclosed, single phase motors with class B insulation and permanently-lubricated ball bearings. Motor shall be protected by internal thermal overload protection.

3) Shaft shall have inherent corrosion resistance.

4) Fan blades shall be non metallic and shall be statically and dynamically balanced.

5) Outdoor fan openings shall be equipped with PVC metal/mesh coated protection grille over fan.

Compressor:

1) Compressor shall be fully hermetic rotary type.

2) Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current.

3) Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.

4) Compressor assembly shall be installed on rubber vibration isolators.

Outdoor Coil:

1) Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.

Refrigeration Components:

1) Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, reversing valve. Provide tamper proof port caps.

Controls and Safeties:

1) Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
   a) A time delay control sequence is provided standard through the fan coil board.
   b) Automatic outdoor-fan motor protection.
c) System diagnostics.
d) Compressor motor current and temperature overload protection.
e) Outdoor fan failure protection.

h. Electrical Requirements:
1) Unit electrical power shall be a single point connection.
2) Unit control voltage to the indoor-fan coil shall be 24 VDC.
3) All power and control wiring must be installed per NEC and all local electrical codes.
4) Unit shall have high-and low-voltage terminal block connections.

i. Special Features (Field Installed):
1) Low-Ambient Kit: Control shall regulate fan-motor cycles in response to saturated condensing temperature of the unit. The control shall be capable of maintaining a condensing temperature of 100° F ± 10° F, with outdoor temperatures to 20° F. Installation of kit shall not require changing the outdoor fan motor.
2) Crankcase Heater.

j. Warranty:
1) 1-Year parts and 5-Year compressor warranty.

2.3 EXHAUST FANS

A. Rooftop Centrifugal Exhaust Fan (up-blast, general use)

1. Description:
   a. Fan shall be a spun aluminum, roof mounted, belt driven, up-blast centrifugal exhaust ventilator.

2. Certifications:
   a. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

3. Construction:
   a. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The windband shall have a rolled bead for added strength. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

4. Wheel:
   a. Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96.

5. Motor:
   a. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.

6. Bearings:
a. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a pillow block housing selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged operating speed.

7. Belts & Drives:
a. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

8. Manufacturer, Capacity & Accessories:
a. See Drawings

B. Utility Vent Set (for kitchen, or lab use):

1. Description:
a. Fan shall be a single width, single inlet, backward inclined steel wheel, belt driven centrifugal vent set.

2. Certifications:
a. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). For restaurant applications, fan shall be listed by Underwriters Laboratories (UL 762) and UL listed for Canada (cUL 762). Fan shall bear the AMCA certified ratings seal for air performance.

3. Construction:
a. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper and side panels shall be heavy gauge steel. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. The fan housing shall be field rotatable to any one of eight discharge positions. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

4. Wheel:
a. Wheel shall be steel centrifugal backward inclined, non-overloading flat blade type. Blades shall be continuously welded to the backplate and deep spun inlet shroud. Wheel hub shall be keyed and securely attached to the fan shaft. Wheel inlet shall overlap a one piece aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96.

5. Motor:
a. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.

6. Bearings:
a. Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball or roller type in a heavy-duty pillow block housing selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged operating speed.

7. Blower Shaft:
a. Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.

8. Belts and Drives:
   a. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified.

9. Manufacturer, Capacity & Accessories:
   a. See Drawings.

2.4 AIR DISTRIBUTION

A. Ductwork:

1. Low pressure ductwork shall be fabricated from galvanized sheet metal, unless otherwise indicated. Construction requirements shall be in accordance with SMACNA - HVAC Duct Construction Standards, metal and flexible, latest edition. All sheet metal ductwork shall be sealed with McGill United Sheet Duct Sealer or equal, in accordance with the International Energy Compliance Code, latest edition. Adjustable (twist) elbows are not allowed. Low pressure ductwork shall be constructed to the following SMACNA static pressure standards:
   a. Supply air ductwork = 2” W.G.
   b. Return, Exhaust, Outside Air Intake ductwork = 1” W.G.

2. Ductwork located in exposed ceiling areas, shall be standard galvanized sheet metal, paint-lock spiral ductwork is not acceptable. All ductwork which is to be installed in exposed ceiling areas shall be stored inside from the time of manufacturing to installation; no outside storage shall be acceptable. Sheet metal shall have a clean, uniform color. Joints shall be sealed evenly and in a professional manner with silver silicon. Discolored or damaged ductwork unacceptable to the Engineer shall be replaced at the Contractors expenses.
   a. Joints: 0” to 20” diameter, interior slip coupling beaded at center, fastened to duct with screws and with sealing compound applied continuously around joint before assembling and after fastening. Sealing compound shall be applied in an evenly and professional manner.
   b. Joints 22” – 72” diameter, use 3-piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Manufacturer shall be Ductmate Spiralmate or equal.
   c. All takeoff or branch entrances shall be by means of factory-fabricated fittings. Field taps shall not be allowed.

3. Low pressure ductwork which is exposed or located in mechanical rooms shall be fabricated from galvanized sheet metal. Construction requirements shall be in accordance with SMACNA HVAC Duct Construction Standards, metal and flexible, latest edition.

4. Low pressure, double wall acoustically insulated ductwork shall have a minimum 1” insulation, & perforated metal lining, & shall be McGill Acoustik27, Metaltec, or equal.

5. Fume hood exhaust ducts:
   a. Fume hood and lab exhaust ductwork shall be single wall 316L stainless steel, ASTM-A312 built for structural strength. Protect finish with mill applied protective plastic/paper throughout construction. All balancing dampers and other accessories located in the fume
The exhaust duct system shall be 316 stainless steel.

1) All lab exhaust ductwork except the individual runouts from the main to the fume exhaust hood.
   a) Duct shall be a minimum of 18 gauge.
   b) Elbows and angles shall have the same gauge as ductwork, inside radius not less than width of ductwork.
   c) The duct system shall be fitted with copper grounding straps, connected to the duct and to an effective grounding system.
   d) Provide drains at low points in ductwork.
   e) See fabrication requirements below for ductwork fabrication and assembly requirements.
   f) Note that all fittings, accessories, etc. in the fume hood and laboratory exhaust ductwork system shall be fabricated from 316 stainless steel.

2) All lab exhaust runouts from the main to fume exhaust hoods.
   a) Duct shall be a minimum of 18 gauge.
   b) Elbows and angles shall have the same gauge as ductwork, inside radius not less than width of ductwork.
   c) The duct system shall be fitted with copper grounding straps, connected to the duct and to an effective grounding system.
   d) Ducts shall be sloped back to their respective hood.
   e) Longitudinal and transverse joints between ductwork and fittings shall be continuous purge welded with Argon gas. Use of spot welds and sealants is prohibited.
   f) Note that all fittings, accessories, etc. in the fume hood and laboratory exhaust ductwork system shall be fabricated from 316 stainless steel.

6. Ductwork penetrating protective elements of fire-rated corridor walls, with no openings into corridor, shall be constructed of minimum 26 gauge galvanized steel.

7. Exterior exposed ductwork shall be fabricated from galvanized sheets. All joints and seams shall be standing-seam type with sealing mastic to provide watertight construction. All ductwork shall be internally insulated as hereinafter specified. All exposed surfaces shall be primed and painted two coats of exterior enamel paint, color as selected by the Architect.

8. Shower and locker room exhaust ductwork shall be constructed of galvanized sheet metal, in accordance with SMACNA standards.

9. Flexible ducts shall be listed per UL-181 standard as Class 1 flexible, acoustical insulated air duct and complying with NFPA Standards 90A and 90B. Ducts shall be insulated with a minimum R-5 value, and shall have a maximum vapor transmission value of .05 perms. Ducts shall be factory made with and composed of: a PE liner duct permanently bonded to a coated spring steel wire helix. Duct shall be chlorine free and carry a ten-year warranty for the labor to replace the duct should there be a factory defect. Low permeability outer vapor barrier of fiberglass bidirectional reinforced metalized laminate shall complete the composite. Pressure rating shall be 6” w.g. and maximum length shall be 6 feet. Attach to duct take-off, diffuser, register, or grille only, with nylon or stainless steel duct clamp or tie. Flexmaster 1-M, Thermaflex M-KE (R6.0), or approved equal.

B. Duct Accessories:

1. Turning vanes shall be installed in all rectangular or square elbows. Vanes shall be installed in vane side rails. Vanes shall be single wall vanes, and be fabricated and installed per SMACNA standards.

2. Volume dampers shall be fabricated from galvanized steel in accordance with SMACNA standards.
Dampers shall have a continuous galvanized steel shaft on ducts 13" diameter or larger, with damper regulators and end bearings. Dampers located above inaccessible ceilings (hard ceilings) shall be furnished with concealed ceiling damper regulators. Dampers shall be pressure rated equal to the design duct pressure rating. Dampers shall be provided at all diffuser and supply/exhaust grille takeoffs, regardless if indicated on the plans. Dampers are not required on the return air takeoffs unless specifically indicated.

3. Flexible connections shall be provided at all rotating fan equipment. Connectors shall be of fire, water, and weather resistant material.

4. Fire dampers shall be UL-labeled with frame, locking assembly, accordion style folded blades, and fusible link. Dampers shall be Style B with blades stored outside of the air stream. Provide duct inspection door at each fire damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel.

5. Combination smoke and fire dampers are to be fusible link type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed with 212 degrees F link and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.

6. Smoke dampers are to be ultra-low leakage (less than 4CFM/ft²) type with factory sleeve and electric operator located exterior to duct 120 V. operator to be spring return, fail closed and UL label. Provide duct inspection door at each damper. Minimum size shall be 8" x 8". Inspection door shall be provided with a steel frame with gasketing around periphery, and a hinged panel. Dampers located in moisture laden air conditions shall have all metal parts made of stainless steel. Belimo operators/actuators only.

7. A plastic flex elbow support by Flexible Technologies Inc., Titus FlexRight, or approved equal, is required at all flex duct elbows supplying ceiling diffusers & return grilles. Elbow support shall be fully adjustable, or be of universal design, to support flexible diameters 6" – 16", sized to fit flex duct. Elbow supports shall be UL rated for use in return air plenum spaces. At the Contractor’s option, a hard elbow may be used in lieu of a flexible elbow.

C. Diffusers, Registers, Louvers, Grilles, Weathercaps:

1. See Drawings for requirement.

D. Duct Cleanliness:

1. Ductwork Delivery to Site
   a. During ductwork being delivered from the premises of the manufacturer, care must be taken to prevent damage during transportation and off-loading.

2. Temporary Storage
   a. Job site duct material storage areas should be clean, dry, and located away from high dust generating processes such as masonry or tile cutters, cutoff saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept. The general contractor should designate a suitable area for temporary storage.
   b. To prevent ductwork material damage from standing water, storage locations should include
pallets or blocking to keep fabricated metal ductwork above the floor surface. If there is a risk of water runoff from above or dusty areas cannot be avoided, coverage should be used to protect stored materials.

3. Installation
   a. Before the installation of individual duct sections, they are to be inspected to insure that they are free from all debris.
   b. All ductwork risers must be covered to prevent the entry of debris into the duct.
   c. Downward facing and horizontal ductwork openings will not be required to be covered.
   d. Access covers shall be firmly fitted in position on completion of each section of the work. Open ends on completed ductwork and overnight work-in-progress shall be sealed.
   e. The working area should be clean and dry and protected from the elements.
   f. The internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust immediately prior to installation.

2.5 PIPING SYSTEMS

A. Condenser Water Piping and Fittings:

1. Piping shall be standard weight (schedule 40), ASTM A53 black steel pipe with 125 pound black, screwed or welded, malleable iron fittings.

2. At the contractor’s option Victaulic, Shurjoint, or Anvil Gruvlock grooved, schedule 40, black steel piping with ASTM A536 ductile iron; ASTM A234 forged steel; or ASTM A53 fabricated steel fittings and couplings may be used. Carbon Steel, A-53B/A-106B with roll grooved-ends may be used in lieu of welded systems. Grooved products must conform to ASTM A536 ductile iron may be used. Carbon Steel, A-53B/A-106B – Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressure, size and method of joining. Pipe ends to be grooved in accordance with the current listed standards conforming to ANSI/AWWA C-606.

3. Grooved Mechanical Couplings

Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ANSI/AWWA A-183, minimum tensile strength 110,000 psi.

a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI 831.1, 831.9, and NFPA 13.
   1) 2” through 12”: Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C) without the need for high temperature lubricants. Basis of design: Victaulic Style 107 or approved equal.

b. Flexible Type: Use in locations where vibration attenuation and stress relief are required.
   1) 2” through 8”: Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C) without the need for high temperature lubricants. Basis of design: Victaulic Style 177.
   2) 10” through 12”: Standard flexible couplings. Gasket shall be Grade “E” EPDM compound with green color code designed for operating temperatures from -30 deg F
4. At the contractor's option, piping may be Type L hard drawn copper, ASTM B88. Fittings shall be cast brass, ANSI/ASME B16.23, or solder wrought copper, ANSI/ASME B16.29. Joints shall be ASTM B32 solder, grade 95TA.

5. At the contractor's option copper tube may be installed with grooved mechanical joints in lieu of soldering. 2"-8" for copper tubing consisting of ductile iron cast housings, complete with a synthetic rubber gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together. Couplings shall be manufactured to connect copper tubing sized tube and fittings. (Flaring of tube and fitting ends to IPS dimensions is not allowed).
   a. Coupling Housings: Ductile iron conforming to ASTM A-536, Grade 65-45-12, coated with copper colored alkyd enamel. Housings cast with offsetting, angle-pattern bolt pads to provide rigidity.
   b. Coupling Gaskets: Gasket shall be Grade “EHP” EPDM compound with red color code designed for operating temperatures form -30 deg F to +250 deg F.
   c. Basis of design: Victaulic Style 607.

6. Piping underground or below slab shall be Schedule 80 PVC, ASTM D1785 or D2241. Fittings shall be PVC, ANSI/ASTM D2466. Joints shall be solvent weld, ASTM D2855, or gasketed, ASTM F477. Piping shall be rated for not less than 150 psig pressure.

B. Refrigerant Piping:
   1. Refrigerant piping shall be manufacturer's standard line sets, in lengths as required for proper installation. Coiling of excess tubing will not be acceptable.
   2. Provide PVC sleeve and caulking at all refrigerant pipe penetrations of exterior walls.

C. Condensate Drain Piping:
   1. Exterior to building, or located in plenum: Piping shall be Type L hard drawn copper, ASTM B88 with solder joints. Copper piping shall not be used on 90% condensing type equipment.
   2. Interior: Piping shall by Type L hard drawn copper, ASTM B88, with solder joints, grade 95TA, or shall be Schedule 40 PVC. Copper piping shall not be used on 90% condensing type equipment.

D. Pipe Hangers and Supports:
   1. See Section 220100 for hanger and support requirements for piping systems. See drawings for seismic support requirements for piping systems.

E. Piping Accessories:
   1. Piping Hydronic Thermometer: Thermometer shall be 3” bimetal dial thermometers with recalibrator with a 0°F to 250°F range and 2°F scale and accurate within 1% of scale range. Thermometer shall be provided with an Vari-angle Form angle stem and thermowell. Thermometers shall be installed in the hydronic system in a neat workman like manner, aligned vertically and horizontally with other thermometers in the system. The thermometers shall be installed no higher than 9'-0" above finish floor and be readable from finish floor. Weiss instrument or approved equal.
   2. Piping Hydronic Pressure Gauges: Pressure gauges shall be 4½” diameter, liquid filled gauges with
ranges to meet 1.5 times the pressure ratings of the system it’s serving. Pressure gauges shall be provided with quarter turn ball valve isolation valves on the source side and on the bleed off line. Pressure gauges shall be installed in the hydronic system in a neat workman like manner, aligned vertically and horizontally with other pressure gauges in the system. The pressure sensors shall be installed no higher than 9'-0” above finish floor and be readable from finish floor. Weiss instrument or approved equal.

3. **Air Vent:** Non-modulating, high capacity, automatic type designed to purge free air from the system and provide positive shutoff at pressures up to 150 psig at a maximum temperature of 250°F. Vent shall be constructed of cast iron body and bonnet with stainless steel, brass, EPDM, and silicon rubber internal components.

F. **Valves:**

1. See Section 15200 for valve requirements.

G. **Grooved Piping Requirements:**

1. **Grooved Pipe Valves:**
   a. **Butterfly Valves – 2” through 12” Sizes:** 300 psi CWP suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree circumferential seating. Seat shall be pressure responsive EPDM. Basis of design: Victaulic Vic®-300 MasterSeal™ or approved equal.
   b. **Check Valves – 2” through 3” Sizes Spring Assisted:** Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, stainless steel non-slam tilting disc, stainless steel spring and brass shaft, nickel-plated seat surface, 365 psi. Victaulic Series 716H / 779 or approved equal.
   c. **General Duty Valves – Tri-Service Valve Assembly:** Combination shut-off, throttling and non-slam check valve.
      1) **2-1/2” through 12” Sizes:** Butterfly valve with memory stop feature assembled with spring assisted, non-slam check valve. Check valve may include venture-like taps for flow measurement. Working pressures to 300 psi. Basis of design: Victaulic Series 761 butterfly valve in combination with Victaulic series 716 or 779 Check valve or approved equal.

2. **Grooved Pipe Specialties:**
   a. **Strainers – Grooved-End**
      1) **T-Type Strainer:** 2” through 12” sizes, 300 PSI T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-14-12) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2”-3” strainer sizes, or No. 6 mesh, 4”-12” strainer sizes, 57% free open area. Basis of design: Victaulic Style 730 / W730 or approved equal.
      2) **Y-Type Strainer:** 2” through 18” sizes, 300 PSI, Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16” (1.6mm) diameter perforations 2”-3” strainer sizes, 1/8” (3.2mm) diameter perforations 4”-12” strainer sizes, and 0.156” (4mm) diameter perforations 14”-18” basis of design strainer sizes. Basis of design: Victaulic Style 732 / W732 or approved equal.
   b. **Suction Diffuser – Flanged outlet with grooved inlet connections,** rated to 300 psi. Ductile iron (ASTM A-536) body, 304 stainless steel frame and perforated sheet diffuser with 5/32” (4.0mm) diameter holes. Removable 20 mesh 304 stainless steel start-up pre-filter, outlets for pressure/temperature drain connections, and base support boss. Basis of design: Victaulic
Series 731-G and W731-G or approved equal.

3. Quality Assurance
   a. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by one manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

4. Execution:
   a. Installation:
      1) Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.
      2) The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
      3) Couplings installation shall be complete when visual metal-to-metal contact is reached.
   b. Training:
      1) A factory trained representative (direct employee) of the grooved product manufacturing company shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.
   c. Application:
      1) A representative of the grooved system supplier shall periodically visit the job site and review installation. Contractor shall fix and/or replace any improperly installed products.
      2) Grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods.
      3) All grooved components shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA.
      4) Grooved end product manufacturer to be ISO-9001 certified.

2.6 PIPING SYSTEMS CLEANING & CHEMICAL TREATMENT

A. Condenser Water Closed Loop Cleaning & Chemical Treatment:

1. The Mechanical Contractor shall fill each hydronic system with clean fresh water prior to cleaning and thoroughly leak check system piping. A qualified water treatment contractor shall be utilized to furnish the cleaning material and supervise the flushing and treatment of the system. Approved water treatment contractors must show proof of similar service for not less than 3 years, and shall have full-time service personnel located within one hour from the job site. A cleaning and passivating agent supplied by the Chemical Treatment Contractor shall be added to the system at the direction of the Treatment Contractor during the leak check process to minimize initial corrosion. If the system is filled multiple times during the leak check and repair process the Mechanical Contractor shall coordinate with the Treatment Contractor to maintain this initial protection. The Treatment Contractor is responsible for providing chemical for up to two refills of the system. If additional chemical is required due to multiple re-fillings the Mechanical Contractor shall be responsible for the additional time and chemical.

EXISTING SYSTEMS –

Do NOT flush existing systems without authorization from the design engineer. The mechanical contractor is to test the existing system for chemicals and water quality, and then provide test results to the design engineer prior to flushing.

For existing systems with glycol, the mechanical contractor is to test the system for glycol content (%) before adding any new piping to the system. Report test results to Owner and Design Engineer.
2. The Mechanical Contractor shall close isolation valves at each heat pump and open the bypass valve to prevent flow through the strainer, flow control device and heat pump during the initial flushing and subsequent cleaning. The side stream filter bag shall be removed during the initial flushing process.

3. Following leak check the closed system shall be flushed by the Mechanical Contractor until the leaving water runs clear. All primary runs shall be flushed at their ends to obtain maximum sweep of debris from the system. The inlet screens on the circulating pumps must be kept clear during this initial cleaning process and inspected following cleaning. When flushing is complete the system is to be left full.

4. Prior to flushing the Mechanical Contractor shall coordinate with Treatment Contractor so that the Treatment Contractor can be available immediately following flush to add cleaning chemical within 4 hours to prevent initial corrosion.

5. Following initial flushing the Chemical Treatment Contractor shall refill all systems with cleaning and passivating agents raising the PH to a minimum of 10, circulate for a minimum of 8 hours and flush until thoroughly clean. All primary piping runs shall be flushed at the ends during this cleaning process. The side stream filter bags shall be inspected during cleaning and changed as required. Cleaning shall continue until these bags no longer show signs of debris.

6. Following cleaning process the Treatment Contractor shall close the bypass valves at each heat pump and open isolation valves for normal operation and check for leaks. The bypass valve handle shall be removed and tied to the valve. A clean bag filter shall be installed in the system.

* The water treatment contractor shall refill system with a mixture of clean water and chemical inhibitor. Add nitrite to system to maintain a nitrite level of 800-1000 ppm. Test for nitrite using a “Drop Test” kit.

7. The Treatment Contractor shall provide final inspection report for inclusion in the Operation and Maintenance Manual. Additionally, the Treatment Contractor shall take loop samples approximately 12 months following completion, add or adjust chemical as required and provide a post construction report to the owner prior to warranty closeout. Chemical required is the responsibility of the Treatment Contractor.

B. Chemical Treatment Station:

1. A chemical treatment station shall be provided by the Treatment Contractor in a 24” x 24” locked cabinet. Station shall include LMI DC4000-1-1 conductivity meter with sensor and A-17-1-1351S chemical pump, or approved equal. The chemical station shall be located inside the mechanical room. Mechanical Contractor shall provide ¾” PVC piping from the discharge of the spray pump of the fluid cooler to the station enclosure with T’s for installation of the conductivity sensor and for chemical injection. Return piping shall be piped back to the fluid cooler sump at the opposite end from the spray pump pickup. The Treatment Contractor shall install the conductivity sensor and injection fitting in the T’s provided and set up initial treatment.

2. Under the scope of this specification the Treatment Contractor shall monitor the tower sump and adjust feed and bleed to maintain proper control of scale and corrosion for a period of one year. A minimum of monthly chemical checks are required during cooling season. The Treatment Contractor shall provide all chemical required during the first year of operation.

2.7 INSULATION
A. General:

1. All insulation shall have composite fire and smoke hazard ratings, as tested by ASTM E-84, NFPA 255, and UL 723, not exceeding:

<table>
<thead>
<tr>
<th>Flame Spread</th>
<th>Smoke Developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

B. Ductwork - External Insulation:

1. Insulation shall be fiberglass insulation with aluminum foil scrim kraft facing. All joints shall be taped with UL listed tape to provide a continuous vapor barrier. The following ducts shall be externally insulated:
   a. Supply ducts in unconditioned spaces (unless internally insulated)
   b. Return ducts in unconditioned spaces (unless internally insulated)
   c. Combustion air ducts
   d. Outside air intake ducts
   e. Exposed ductwork located within conditioned spaces shall not be externally insulated

2. Insulation thickness & "R" values shall be as follows:
   a. R-6 – ducts located in unconditioned spaces (such as above ceiling, but below roof insulation).
   b. R-8 – ducts located outside of the building's insulation envelope (such as above the attic insulation).

C. Ductwork - Internal Insulation:

1. Insulation shall be flexible fiberglass duct liner. Liner shall be attached with 100% coverage of manufacturer's recommended adhesive and welded or mechanically fastened galvanized steel pins. All exposed edges of liner shall be coated with adhesive. Duct dimensions shown are net air side face-to-face of duct liner. The following ducts shall be internally insulated:
   a. Supply and Return ducts within 15'-0" of air handler
   b. Supply and Return ducts in mechanical rooms
   c. 15'-0" downstream of heat pumps
   d. 15'-0" downstream of fan coil units
   e. Exterior ducts (located outdoors)
   f. Ducts as indicated on plans

2. Insulation thickness & "R" values shall be as follows:
   a. R-6 – ducts located in unconditioned spaces (such as above ceiling, but below roof insulation, or buried ductwork)
   b. R-8 – ducts located outside of the building's insulation envelope (such as above the roof).

D. Piping Insulation - Refrigerant Piping:

1. Insulation on refrigerant suction piping shall be one-piece preformed flexible formed tubing with built-in closed cell vapor barrier. Seal laps and butt joints with moisture resistant adhesive to provide a continuous vapor seal. Exterior insulation shall be coated with a weather resistant coating as recommended by insulation supplier. Insulation thickness shall be as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerant line set type</td>
</tr>
<tr>
<td>Located within the conditioned spaces</td>
</tr>
</tbody>
</table>
Suction: ½”  1”  1”
Liquid: not required
Discharge (hi/low pressure): 1”  1”  1”

Located outside the conditioned spaces

Suction: ½”  1”  1”
Liquid: not required
Discharge (hi/low pressure): 1 ½”  1 ½”  2”

### 2.8 VIBRATION ISOLATION

A. **General:**
   1. All rotating equipment and appurtenances connected to rotating equipment shall be vibration isolated from the supporting structure. No metal to metal contact will be permitted between fixed and floating parts. All metal isolators exposed to weather shall be hot dipped galvanized after fabrication. Piping connected to rotating equipment shall be hung with spring hangers for first 50 pipe diameters.

B. **Floor Mounted Spring Isolators:**
   1. Isolators shall be free standing, laterally stable, and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter to operating spring height of 1.0 and an additional travel to solid equal to 50% of rated deflection.

C. **Floor Mounted Neoprene Pads:**
   1. Isolators shall be neoprene waffle or combination neoprene and cork sandwich. Pads shall be sized and selected as per manufacturers loading requirements.

D. **Spring Hangers:**
   1. Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional spring travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.

### 2.9 SEISMIC SUPPORTS

A. All equipment, ductwork, and piping shall be seismically supported as required by the International Building Code, latest edition. Support details shall be as indicated on the Drawings.

### 2.10 CONTROL SYSTEM

A. **General:**
   1. The Control Contractor shall be responsible for a complete and operable control system, including equipment, installation, and accessories required to perform the functions specified on the drawings. The Control Contractor shall supervise the installation of all control equipment and accessories and shall submit shop drawings of the proposed system for approval. See Section 230900.
2. The Control Contractor shall furnish and install all control conduit and wiring. All wiring shall be installed in EMT in accordance with the section Electrical. Provide plastic covered wires of not less than 18-gauge (16-gauge if longer than 50'), with at least one spare circuit at each control device. Control voltage shall not exceed 30 volts, except in starter pilot circuits.

3. The Mechanical Contractor shall be responsible for installing all control valves, water flow switches, temperature wells, control dampers, and related equipment which is furnished by the Control Contractor.

4. The control system shall be basically electric, with supplementary electronic devices as required.

5. The Control Contractor shall be Climatech of Boise.

B. Control Equipment and Accessories:

1. Control Dampers:
   a. All control dampers are to be furnished under this section, except those specified to be furnished with the air handling units. Damper blades shall be fabricated of 22-gauge galvanized sheet steel and frames shall be not less than 16-gauge galvanized steel. Blades shall be maximum 10 inches wide, 50 inches long, and shall be provided with neoprene gasketed edges and oilite bronze or nylon bearings. Dampers shall be ultra-low leakage, opposed blade type for proportional action and parallel blade type for two-position action. Leakage performance shall be maximum of 3 cfm per sq. ft. @ a pressure differential of 1” w.g. Provide damper operators for all motorized dampers and louvers. Belimo or approved equal. Submittals shall include leakage and pressure drop data for all control dampers. All outside air dampers shall fail closed.

2. Control Valves:
   a. Control valves 2-1/2" and smaller shall be screwed, 3" and larger shall be grooved or flanged. Screwed valves shall be bronze or cast brass, grooved valves shall be ductile iron, and flanged valves shall be cast iron or cast steel. Three way valves shall have contoured plugs for linear flow characteristics and constant total flow throughout the stem travel. Straight-thru valves shall be single seated and have equal percentage characteristics for water service. Flat discs shall be used for on-off control only. All valves shall be stainless steel stems, replaceable seats, and self-adjusting Teflon or rubber packing. All heating control valves shall fail open. Belimo or approved equal.

3. Air Duct Smoke Detector:
   a. Smoke detector shall be products of combustion detector and shall be UL listed. The unit shall be designed for detection of combustion gases, fire, and smoke in air ducts in compliance with NFPA Pamphlet 90A. The sheet metal contractor shall provide a minimum 18"x18" hinged access door, in inaccessible ceilings, for each detector that is furnished. The sheet metal contractor is also responsible for providing all necessary transitions in the ductwork for mounting of the duct detector.

4. Thermostats:
   a. Thermostats shall be 7-day programmable type, with automatic changeover from heating to cooling, be provided with auxiliary contacts.
   b. Thermostats installed on exterior walls shall be mounted on an insulating block, or on foam insulation filled J-box.
   c. All thermostats shall have a mounting height of 46 inches, to the centerline of the device, unless otherwise noted on electrical drawings.
5. Equipment Control Schematics:
   a. See Drawings for schematics and sequence of operations.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. General:
   1. Install all materials and equipment as shown and in strict accordance with the applicable codes for
      the State and/or city. Plans do not attempt to show exact details of all piping and ductwork, and no
      extra payment will be allowed for offsets required due to obstructions by other trades. All work
      shall be done in a neat and orderly fashion and left in a condition satisfactory to the
      Architect/Engineer.
   2. All piping shall be run parallel or perpendicular to established building lines. Install piping so as to
      allow for expansion. Install all valves with stems horizontal or above. Install air vents at all high
      points. Provide all piping which passes through walls, floors, or ceilings with standard weight pipe
      sleeves.
   3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from
      pipe end to groove. Gasket shall be molded and produced by the grooved coupling manufacturer.
      Verify gasket grade is suitable for the intended service. The grooved coupling manufacturer’s factory
      trained representative shall provide on-site training for the contractor’s field personnel in the use of
      grooving tools, application of groove, and installation of groove end products.
   4. Install the grooved piping and fittings in accordance with the latest recommendations as published by
      the manufacturer. Pipe shall be square cut, +/-0.030”, properly deburred and cleaned. Mark pipe
      ends at the required location using a gauge supplied by the Manufacturer to ensure full insertion into
      the coupling or fitting during assembly. Use a manufacturer’s tool with proper sized jaw for pressing.

B. Insulation:
   1. All piping insulation shall be applied over clean, dry surfaces after system has been pressure tested
      and any leaks corrected. Finished appearance of all insulation shall be smooth and continuous.
      Provide coat of insulating cement where needed to obtain this result.
   2. Flexible duct insulation shall be secured to duct surface with 4-inch wide bands of adhesive applied
      on maximum 18-inch centers. Additional galvanized tie-wire support shall be furnished as required
      and recommended by the insulation manufacturer.

C. Diffusers, Registers and Grilles:
   1. All diffusers, grilles, and registers shall be installed tight on their respective mounting surfaces and
      shall be accurately centered on ceiling tile, recesses, windows, or doors.

D. Ductwork:
   1. All sheet metal work shall be done by qualified, experienced mechanics in accordance with the
      requirements of ASHRAE and the latest edition of the applicable SMACNA Manual. All ductwork
      shall be installed in a neat and orderly manner, and shall be adequately supported to prevent vibration
or sagging. All sheet metal ductwork shall be sealed with United-Sheet Metal Duct Sealer or equal.

E. Air Conditioning Units:

1. Units shall be installed approximately where shown on the plans to provide access space for filter changing, motor, drive and bearing servicing, and fan shaft and coil removing. Pipe drain pan connection through a running trap to floor drain. Unit shall not be operated until filters are installed. Isolate sheet metal ducts from all fans with flexible connectors.

F. Condensing Units/Heat Pumps:

1. Units located on flat rooftops shall be provided with Miro Industries Model HD, or equal, heavy duty galvanized roof support with adjustable legs, sized 6 inches larger, in each direction, than equipment footprint.

END OF SECTION 230100
SECTION 230150 - MECHANICAL START-UP

PART 1 - GENERAL

1.1 SCOPE:
   A. General:
      1. The purpose of the mechanical start-up is to provide the owner of the facility with a high level of assurance that the mechanical system has been installed and operates per the requirements of the mechanical construction plans and specifications. The Mechanical General Provisions, Section 230000, is to be included as a part of this section of the specifications.
   B. Pre-start and Start-up checklist:
      1. The contractor shall be responsible for the completion of pre-start and start-up checklist forms. These forms can usually be obtained from the equipment manufacturer. If the forms cannot be obtained from the manufacturer, forms may be obtained from the Engineer.
      2. After completion of pre-start and start-up checklists, the contractor shall provide a copy of the pre-start and start-up checklist to the engineer for review and approval prior to substantial completion.
      3. Approved Mechanical Equipment Start-up forms shall be included in the operations and maintenance manual.

PART 2 – START-UP PROCESS

2.1 RESPONSIBILITIES
   A. Mechanical Contractor:
      1. Coordinate with other trades involved in the installation of mechanical equipment to complete the requirements of mechanical start-up specifications.
      2. Complete the pre-start and start-up checklist forms obtained from the equipment manufacturer or the Engineer.
      3. Notify the mechanical engineer of tests to be witnessed. Contractor shall give the engineer a minimum of 48 hours’ notice prior to test.
   B. Engineer:
      1. Review the completed pre-start and start-up check lists provided by the mechanical contractor.
      2. At final inspection, spot check items on the pre-start and start-up checklist forms to insure that they have been completed.
2.2 EQUIPMENT PRE-START

A. Before starting any equipment or system, complete the system pre-start checklist forms. As part of the pre-start process, the following items shall be completed as applicable:

1. Piping systems shall be pressure tested as specified, found to be tight, with reports submitted.
2. Piping systems shall be flushed and cleaned as specified, all required reports submitted, and the system shall be filled or charged per plans.
3. Air system cleaning is complete and final filters shall be installed.
4. Vibration isolation and seismic restraints shall be installed per plans and specifications.
5. Equipment drives shall be aligned.
6. Electrical services shall be installed and checked.
7. Control points checkouts shall be completed.
8. Safety controls shall be installed and operation checked.
9. Manufacturer’s representatives have carried out major equipment start-up, and all checks shall be documented on the relevant checklists as they are carried out.
10. Equipment has been thoroughly cleaned (interior and exterior of units), of construction debris.
11. Deficiencies or incomplete work shall be corrected and pre-start shall be repeated until the installation is ready for operation.

2.3 EQUIPMENT START-UP

A. After the pre-start up process described in Section 2.2, complete the system start-up checklist and document findings with forms provided. As part of the Start-up process, the following items shall be completed as applicable:

1. Air systems balanced as specified in plans and specifications.
2. Water systems balanced as specified in plans and specifications.
3. Problems revealed during balancing of air and water systems shall be corrected.
4. All automatic temperature controls devices shall be calibrated, including adjustments to control valves and damper actuators.
5. Set up or program controls for accurate response and precise sequencing to meet specified performance.
6. The controls contractor and balancing contractor shall adjust and set air flows and calibrate controls of equipment as applicable.
7. Ensure final adjustments to vibration isolation and seismic restraints are carried out per the manufacturer’s requirements.

8. Check the operation of all fire dampers; smoke dampers and combination fire/smoke dampers.

B. Deficiencies or incomplete work shall be corrected, and the startup shall be repeated until correct installation and function has been confirmed and the installation is ready for engineer verification.

2.4 TRAINING AND INSTRUCTION

A. Once the substantial completion has been approved, the mechanical contractor shall provide the Owner and engineer with a training schedule for operation of the mechanical equipment and systems and their controls as listed in the specifications and plans. Reference Section 230000 Mechanical General Provisions, “Project Closeout” of these specifications.

PART 3 – EXECUTION

A. The following systems and equipment shall be completed under the mechanical start-up plan as described above and documented with equipment pre-start and start-up forms provided.

1. Packaged Rooftop Unit

2. Hydronic Heat Pumps

3. Ductless Split System

4. Heat Recovery Unit

5. Exhaust Fans

B. Pre-start and start-up forms are to be provided to the engineer for final approval before substantial completion.

C. Approved forms shall be included in the operations and maintenance manual.

END OF SECTION 230150
PART 1 - SYSTEM OVERVIEW

1.1 DDC CONTROL SYSTEM

A. Statement of Intent:

1. The intent of this specification is to provide a high-quality Direct Digital Control system with Web based software front end and top-of-the-line control hardware. System is to include a Graphical User Interface (GUI) residing on a WebServer accessible with an industry standard non-proprietary WebBrowser. Connectivity shall be over the owner’s internal Ethernet system and, when allowed, over the Internet using the servers IP address. If connection to an Intranet or to the Internet is not available on initial installation the server shall be accessed via a web browser locally hosted on the server. The graphic user interface shall display real time values of all system operating conditions. Additionally, it shall include graphic displays of system programming, operating logic and logic flow. It shall be capable of displaying that logic flow with real time values of logical inputs and outputs. This graphical display capability is required for system diagnostics of both the mechanical systems controlled by the DDC system and of the operating logic and sequences themselves. The features of the system must be fully installed, configured and demonstrated in a manor that provides maximum benefit to the end user.

B. Specification Compliance:

1. These specifications are intended to provide a minimum capability for the DDC system. Manufacturer’s data sheets included in the submittals will be reviewed to verify significant hardware and software system features. Key system features must be documented by manufacturer’s data sheets in the submittals or by demonstration of an existing installation.

Approved DDC Contractor and System

DDC Control System shall be:

Automated Logic WebCTRL by Clima-Tech Corporation.

Contractors wishing to provide pricing for this project shall submit request to project Engineers not later than 14 working days prior to bid opening date. This is to allow for system demonstration for owner and design team prior to bid date.
sensors, control valves, control valve actuators, dampers, damper actuators and any other items necessary for a complete system and sequence of control, except those valves, dampers and actuators specified to be furnished by equipment supplier. When actuators are specified to be furnished by equipment supplier, that supplier shall be responsible for coordination of actuator control input for interface with DDC system without use of transducers. Automatic control valves, dry wells for fluid temperature sensors, dampers and actuators shall be installed by Mechanical Contractors.

2. Specifically the ATC Contractor shall furnish the following:

Individual unitary control modules for each unitary system:
- Heat pumps
- VAV boxes
- Unitary package rooftop units
- Fan coils
- VVT boxes

Individual control modules for all non unitary air handlers or package units:
- Energy recovery units
- Constant volume air handling units
- Makeup air units

General purpose modules for control of central fan, pump, chiller, boiler or tower operation:
- Hydronic loop heat pump central plant operations
- Hot water central plant operations

Required peripheral mechanical components to be furnished by ATC contractor:
- Zone damper actuators
- Economizer damper actuators not specified as part of mechanical equipment
- Control dampers not specified as part of mechanical equipment
- Condenser water valves and actuators
- Supply air pressure sensors and transducer to 0-10 vdc VFD control
- Building air pressure sensors
- Water pressure sensors
- Variable frequency drives
- Electrical demand monitoring hardware

Required non HVAC controls to be furnished by ATC contractor:
- Lighting control panels

Required software integration to other digital control systems:
- Interface to variable frequency drives
- Interface to HVAC air handlers or package units
- Interface to boilers
- Interface to power monitoring systems

B. Control Wiring and Interface to Line Voltage Control:

1. ATC Contractor shall be responsible for all conduit and back boxes unless indicated on the electrical drawings for the Electrical Contractor to provide and install. Contractor shall be responsible for control wiring to all control modules, sensors, pilot duty control relays and
actuators required to provide sequences of operation as noted in Part 5, except those controllers and peripherals required to be furnished under other specification sections, e.g. Chiller Control Panels. Installation of devices provided by others shall be the responsibility of the contractor providing those devices. ATC contractor shall provide mechanical control interface to boilers, chillers, pumps and fans except where specified to be software control interface. Typical control interface shall include pilot duty relays where interface to line voltage switching devices is required. ATC scope of responsibility shall be limited to Class 2 Limited Energy systems. ATC Contractor shall provide all control conduit within mechanical room or at equipment locations required to connect components included within this section unless specifically shown on Division 16 drawings. Electrical Contractor shall provide all required conduit, contactors, magnetic starters and motor control centers required for operation of mechanical systems except where specifically noted to be provided by equipment manufacturer.

Unitary equipment will be supplied with required fan relays, compressor contactors, electric heat sequencers and transformer ready for connection to control modules.

The following matrix defines the scope of responsibility for the various trades:

<table>
<thead>
<tr>
<th>System</th>
<th>Item Number</th>
<th>Description</th>
<th>Furnished By</th>
<th>Installed By</th>
<th>Class II Control Wiring by</th>
<th>Class I Power Wiring by</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDC</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- a</td>
<td></td>
<td>ATC Routers</td>
<td>C</td>
<td>C</td>
<td>C'</td>
<td>E</td>
</tr>
<tr>
<td>- b</td>
<td></td>
<td>ATC Panels</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>- c</td>
<td></td>
<td>DDC Sensors-Temperature, pressure, flow etc</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>N/A</td>
</tr>
<tr>
<td>- d</td>
<td></td>
<td>Control relays, control transformers</td>
<td>C</td>
<td>C</td>
<td>C²,3</td>
<td>E</td>
</tr>
<tr>
<td>All HVAC</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- a</td>
<td></td>
<td>Automatic Control Dampers</td>
<td>C³</td>
<td>A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>- b</td>
<td></td>
<td>Damper actuators</td>
<td>C³</td>
<td>A</td>
<td>C⁵</td>
<td>E⁵</td>
</tr>
<tr>
<td>- c</td>
<td></td>
<td>Automatic Control Valves</td>
<td>C⁴</td>
<td>M</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>- d</td>
<td></td>
<td>Valve actuators</td>
<td>C³</td>
<td>M</td>
<td>C⁵</td>
<td>E⁵</td>
</tr>
<tr>
<td>- e</td>
<td></td>
<td>VAV Box Controllers</td>
<td>C</td>
<td>C⁷</td>
<td>C⁷</td>
<td>N/A</td>
</tr>
<tr>
<td>- f</td>
<td></td>
<td>VAV Boxes</td>
<td>A</td>
<td>A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>- g</td>
<td></td>
<td>Air Flow Rings for VAV</td>
<td>A</td>
<td>A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>- h</td>
<td></td>
<td>Circuit Setters for Hydronic Systems</td>
<td>P</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Unitary Equipment</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- a</td>
<td></td>
<td>Controllers</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>N/A</td>
</tr>
<tr>
<td>- b</td>
<td></td>
<td>DDC Sensors-Temperature, pressure, flow etc</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>N/A</td>
</tr>
<tr>
<td>- c</td>
<td></td>
<td>Control relays, control transformers</td>
<td>OEM</td>
<td>OEM</td>
<td>OEM</td>
<td>E</td>
</tr>
<tr>
<td>- d</td>
<td></td>
<td>Conduit to zone wall temperature</td>
<td>E</td>
<td>E</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Description</td>
<td>Quantity</td>
<td>Model</td>
<td>Vendor</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------</td>
<td>--------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air Handling Units 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- a Controllers</td>
<td></td>
<td>C</td>
<td>C</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- b DDC Sensors-Temperature, pressure, flow etc</td>
<td></td>
<td>C</td>
<td>C</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- c Magnetic motor starters</td>
<td></td>
<td>E</td>
<td>E</td>
<td>C²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- d HOA Switch</td>
<td></td>
<td>E</td>
<td>N/A</td>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- e Disconnect switches, thermal overloads, manual operating switches</td>
<td></td>
<td>E</td>
<td>N/A</td>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- f Freeze protections thermostats</td>
<td></td>
<td>C</td>
<td>C</td>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- g Supply air and building static pressure controls and tubing to remote locations.</td>
<td></td>
<td>C</td>
<td>C</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- h High Static Pressure Safety switch and monitor w/Pilot Duty Relay for Line Voltage Break</td>
<td></td>
<td>C</td>
<td>C</td>
<td>E¹²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- i Refrigerant and heating controls and safeties</td>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- j VFD</td>
<td></td>
<td>C</td>
<td>E</td>
<td>C³</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air Handling Units 5</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- a Controllers</td>
<td></td>
<td>OEM</td>
<td>OEM</td>
<td>OEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- b Gateway if Required</td>
<td></td>
<td>OEM</td>
<td>OEM</td>
<td>M¹³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- c Integration Wiring to ATC</td>
<td></td>
<td>C</td>
<td>C</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- d Magnetic motor starters-Factory Installed</td>
<td></td>
<td>OEM</td>
<td>OEM</td>
<td>OEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- e HOA-Factory Installed</td>
<td></td>
<td>OEM</td>
<td>OEM</td>
<td>OEM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- f Disconnect switches, thermal overloads, manual operating switches-Factory Installed</td>
<td></td>
<td>OEM</td>
<td>OEM</td>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- g Freeze protections thermostats</td>
<td></td>
<td>C</td>
<td>C</td>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- g Supply air and building static pressure controls and tubing to remote locations.</td>
<td></td>
<td>OEM</td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- h High Static Pressure Safety switch and monitor w/Pilot Duty Relay for Line Voltage Break</td>
<td></td>
<td>OEM</td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- h Refrigerant and heating controls and safeties</td>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
<td>Manufacturer</td>
<td>OEM</td>
<td>Controls</td>
<td>Note: Scope of Integration Responsibility in ATC Specification</td>
<td>ATC Specification</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
<td>--------------</td>
<td>-----</td>
<td>----------</td>
<td>-------------------------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Boilers</td>
<td>VFD-Factory Installed</td>
<td>OEM</td>
<td>OEM</td>
<td>C^8</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>w/out Factory Supplied Controls</td>
<td>Controllers</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>DDC Sensors-Temperature, pressure, flow etc</td>
<td></td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Gas Train or Electrical Sequencing Controls and Safeties</td>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>E</td>
</tr>
<tr>
<td>Boilers</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with Factory Supplied Controls</td>
<td>Controller</td>
<td>M</td>
<td>M</td>
<td>M^13</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Note: Scope of Integration Responsibility in ATC Specification</td>
<td>Gateway if Required</td>
<td>M^13</td>
<td>M</td>
<td>M^13</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integration Wiring to ATC</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Fluid Cooler</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with Factory Supplied Controls</td>
<td>Controller</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Note: Scope of Integration Responsibility in ATC Specification</td>
<td>Gateway if Required</td>
<td>M^13</td>
<td>M</td>
<td>M^13</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electrical Sequencing Controls and Safeties</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integration Wiring to ATC</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Plumbing</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thermo Wells</td>
<td>P</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure Sensor taps</td>
<td>P</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pressure Sensor surge traps</td>
<td>P</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature and Pressure Gauges</td>
<td>P</td>
<td>P</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Pump Motors</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magnetic Motor Starters</td>
<td>E</td>
<td>E</td>
<td>C^2</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HOA Switch</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disconnect switches, thermal overloads, manual operating switches</td>
<td>E</td>
<td>E</td>
<td>N/A</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VFD</td>
<td>C</td>
<td>E</td>
<td>C^8</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Smoke/Fire</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smoke/Fire Sensors, area</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smoke/Fire Sensors, duct</td>
<td>E</td>
<td>E</td>
<td>E-C^10</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smoke/Fire Damper actuators</td>
<td>M</td>
<td>OEM</td>
<td>E</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fire alarm control panel</td>
<td>E</td>
<td>E</td>
<td>E-C^11</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

A - Air Conditioning Sheet Metal Contractor
<table>
<thead>
<tr>
<th>C - ATC Controls Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>E - Electrical Contractor</td>
</tr>
<tr>
<td>M - Mechanical Contractor</td>
</tr>
<tr>
<td>OEM - Original Equipment Manufacturer</td>
</tr>
<tr>
<td>P - Plumbing Contractor</td>
</tr>
</tbody>
</table>

1. Ethernet connection to Owner Intranet will be provided by data cabling contractor or owner.
2. ATC Contractor shall provide pilot duty relays where required to switch control circuit for larger Mag Starters or Contactors.
3. See note regarding transformers, relays etc for Unitary Equipment.
4. ATC Contractor shall provide all dampers and valves unless specified to be supplied with Equipment. Refer to specifications. When dampers and valves are supplied with equipment wiring shall be completed by OEM.
5. Where damper or valve actuators are supplied with Equipment, mechanical contractors shall coordinate with ATC for required signal.
6. Electrical contractor shall provide line voltage wiring for line voltage dampers and valves only.
7. When specifications require VAV box controllers to be provided to OEM for factory installation control wiring shall be completed to all other devices installed at the factory, e.g. Sequencers for electric heat staging. ATC Contractor shall be responsible for Low Voltage power to VAV controllers.
8. ATC requirement for control wiring to VFD is limited to any required connection to controllers provided by ATC contractor. Control wiring to any controllers furnished by other shall be provided under the scope of the contractor providing VFD.
9. Where Sequences of Operation required alarming by ATC systems. Duct sensors furnished by the Smoke/Fire contractor shall include auxiliary contacts for ATC connection.
10. ATC control wiring to Smoke/Fire detectors is limited to connection required for alarming sequences in Sequences of Operation. Fan shutdown shall be hard wired connection by Electrical contractor to the mag starter.
11. Smoke/Fire contractor shall make a single point connection available at the central S/F panel for general alarm signal to ATC. Wiring to ATC system shall be responsibility of ATC contractor.
12. Electrical Contractor is responsible for wiring from pilot duty relay for hard wired shutdown of fan motor.
13. Connections from OEM supplied controllers and gateways shall allow connection to ATC system without additional hardware. Wiring between OEM device and ATC system shall be responsibility of ATC Contractor.

Automatic Temperature Contractor shall be responsible for all programming of controls furnished by them to accomplish the required integration. ATC shall provide necessary hardware to maintain these programs. Local area network wiring required for connection to interface hardware provided under the ATC project scope is the responsibility of the Controls Contractor. If Ethernet connection to third party controls is required, that network connection shall be the responsibility of others.

Suppliers of equipment that is required to be integrated with the DDC system shall be responsible to coordinate integration software protocol and connectivity with Controls Contractor(s) prior to bid to insure satisfactory integration and system operation. Equipment suppliers are required to confirm that their factory installed or provided controls are capable of achieving sequences of operation listed under this section and that required points are visible and available for required interface programming for integration to the DDC system. If specified sequences can not be met with factory installed or provided controls the equipment supplier shall be responsible to furnish and install required external controls or
peripheral devices. Any required communication wiring between digital control devices provided by equipment suppliers shall be the responsibility of that supplier. This may be under separate agreement with the Controls Contractor.

Equipment suppliers shall provide complete points list including Usage Description, Addresses and Device ID numbers, and network number if applicable.

Acceptable protocols:
Variable Frequency Drives, lighting systems or power monitoring systems shall use either Modbus or BACnet software protocols for integration to this DDC system.

All other systems shall use BACnet software protocol for integration to this DDC system.

C. Commissioning:

1. ATC Contractor shall be responsible for self-commissioning of all hardware and software furnished with the project. Completed field commissioning sheets shall be included with the final “as-built” O&M manuals. These sheets shall include validation check fields for all physical and LAN inputs and outputs and graphics for each operating unit or system within the facility. Each system and point shall be listed, using logical names for future reference by the owner. Commissioning shall include calibration and verification of operation of each I/O and graphic field. Functional commissioning of software programming to meet sequences of operation as submitted and approved shall be verified on the field commissioning sheets.

D. Training and Technical Support:

1. Contractor shall provide 4 hours of training to owner representatives on operation and servicing of automatic temperature control system. Training shall be oriented to making the owner self sufficient in the day to day use and operation of the DDC system. Additionally the training shall include information specifically focused on showing the owners representative methods of troubleshooting the mechanical systems using the DDC system. For this purpose, the trainer must be well grounded in both DDC system operation and in mechanical systems service.

2. The contractor shall provide unlimited phone technical support to the owner’s representative during the one year warranty period. If the technical support location of the contractor is outside of the toll free calling area for the customer, the contractor shall have a toll free number or accept collect calls for the purpose of providing technical support.

3. In addition to required technical support and training Contractor shall make available access to factory approved training classes. Classes shall be scheduled multiple times during the first year to allow flexibility for Owner’s representative to attend. Tuition to these classes shall be included within the scope of this project. If course locations are more than 200 miles from the project site, cost of transportation, lodging and meals shall be included within the scope of this project.
1.3 SUBMITTALS AND O&M MANUALS

A. Submittals:

1. Submittals shall include the following sections:
   Shop Drawings with:
   - Title Page
   - Table of Contents
   - Typical Device Wiring Drawings
   - Summary Bill of Materials
   - Sequences of Operation
   - Local Area Network Drawings
   - Drawings for all operating systems showing both equipment and module connections

   (Note: drawings for individual operating systems shall include individual Bills of Materials)

   Manufacturers specification data sheets for all control modules, sensors, dampers, valves, actuators, flow switches, current sensors and transducers required in the project.

   If the contractor wishes to substitute any item after approval of submittal they shall submit appropriate data sheets for approval before including substituted product on the project.

B. O&M Manuals:

1. O&M Manuals shall be furnished upon project completion and include technical instructions for all items originally included in the submittal with "as built" modifications and completed Commissioning Worksheets. O&M Manuals shall be in a separate three ring binder.

   Contractor’s toll free technical support number or the words “Call Collect” with the contractor’s regular phone number shall be on the front of the manual.

1.4 SYSTEM SOFTWARE

A. System Software:

1. All operating program and site specific software shall be furnished to the owner on 3½” diskettes or CD ROM disks.

PART 2 - CONTRACTOR CAPABILITY

1. Contractor shall maintain toll-free technical support phone line or accept collect phone calls during warranty period.

2. Contractor shall provide service within 24 hours.

3. Contractor service and installation technicians shall be technically proficient in both control systems and mechanical service.
PART 3 - PRODUCT CAPABILITY - HARDWARE

3.1 SYSTEM SERVER

A. Software shall be installed on owner furnished server. Specifications for this server will be provided to the owner prior to installation.

3.2 FIELD HARDWARE

A. BACnet Compatibility:

1. The system shall be fully native BACnet at the time of installation. The system shall use BACnet as the native communication protocol between distributed controllers communicating on the controller network (i.e. Field Bus) and must, as a minimum, support the following Objects and Application Services (Conformance Class 3):

<table>
<thead>
<tr>
<th>Objects</th>
<th>Binary Input Services &gt;</th>
<th>Readproperty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary Output</td>
<td></td>
<td>Readproperty</td>
</tr>
<tr>
<td>Binary Value</td>
<td></td>
<td>I-Am</td>
</tr>
<tr>
<td>Analog Input</td>
<td></td>
<td>I-Have</td>
</tr>
<tr>
<td>Analog Output</td>
<td></td>
<td>ReadMultiple Property</td>
</tr>
<tr>
<td>Analog Value</td>
<td></td>
<td>WriteMultiple Property</td>
</tr>
<tr>
<td>Calendar</td>
<td></td>
<td>Who-Has</td>
</tr>
<tr>
<td>Schedules</td>
<td></td>
<td>Who-Is</td>
</tr>
</tbody>
</table>

B. Distributed Control:

1. System shall observe the concept of distributed control. All modules shall have “stand alone” capability and shall maintain operator setpoints without connection to primary controllers or central station equipment. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network. Equipment operating logic, schedules and current trends shall reside in control modules serving each system. Use of global modules required to maintain programming, schedules or current trend data are not acceptable.

C. Ethernet Gateway Routers:

1. System shall include an Ethernet Router/Gateway between the control module network and owners Ethernet. This gateway shall route BACnet communications between the control module network and the owners IP network. If the system is not to be connected to customer Ethernet the gateway shall be capable of connection via a web browser on the local host server.

D. Control Modules:

1. Control modules shall include required inputs and outputs to meet sequence of operation and points list. Digital outputs shall be dry contact relays and analog outputs shall be industry
standard 0-10 vdc, 2-10 vdc or 4-20 milli-amp. Triac digital outputs are not acceptable. Modules shall be fully programmable for maximum system flexibility. Application specific controllers are not acceptable.

2. All modules shall have battery backup capable of maintaining all programs, setpoints, schedules and trend information for a minimum of 7 days.

3. All schedules and current trends shall be maintained in the individual control modules. The modules shall be capable of maintaining sufficient trend samples to report 24 hours of trend history in 5 minute increments for each input or output.

E. Temperature Sensors:

1. Wall mounted zone temperature sensors shall be 10 k ohm thermistor. Zone sensors in primary occupied areas other than restrooms, hallways or storage rooms shall have setpoint adjustment to allow the occupants to raise or lower setpoint within operator defined parameters. Additionally, sensors in these primary areas shall have a push button to return the system to normal occupancy setpoints for an operator defined period. Exception will be common areas. Zone sensors for restrooms, hallways, storage rooms, gymnasiums, auditoriums and locker rooms shall be mounted on the back of an aluminum electrical box cover plate designed for zone sensing application. Gymnasium sensors shall also include a key access override feature.

2. All other temperature sensors shall be industry standard thermistor or 4-20 milli-amp. Immersion sensors shall be mounted in a blind well for future serviceability.

F. Valve and Damper Actuators:

1. Actuators shall be manufactured by Belimo. Torque shall be rated for required load. Modulated actuator input shall be industry standard 0-10 vdc, 2-10 vdc, 4-20 milli-amp, floating motor (tri-state), or pulse width modulation. Two or three position operation is not acceptable for economizers, VAV dampers, multizone dampers, valves or any other application specifying modulated operation.

G. Dampers:

1. Outside air control dampers shall have neoprene or vinyl-grip blade seals, stainless spring steel edge seals and a specified leakage rate of not more than 65 CFM/damper face area at 2” W.G. static pressure drop.

H. Wire:

1. All wiring in open areas at heights below 12 feet must be run in conduit, otherwise control wiring may be run open in accessible ceiling or underfloor areas. Control wiring in non-accessible ceilings, walls or floors shall be in conduit. All wiring not in conduit or control cabinets shall be rated for plenum installation. Communication wiring shall be run in data cable tray whenever possible.
PART 4 - PRODUCT CAPABILITY - SOFTWARE

4.1 BACnet COMPATIBILITY

A. The system shall be fully native BACnet at the time of installation. This means that the system must use BACnet as the native communication protocol between distributed controllers communicating on the controller network (i.e. Field Bus) and must, as a minimum, support the following Objects and Application Services (Conformance Class 3):

<table>
<thead>
<tr>
<th>Objects</th>
<th>Services</th>
<th>Object Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary Input</td>
<td>Binary Output</td>
<td>Readproperty</td>
</tr>
<tr>
<td>Binary Value</td>
<td>Binary Value</td>
<td>Writeproperty</td>
</tr>
<tr>
<td>Analog Input</td>
<td>Analog Input</td>
<td>I-Am</td>
</tr>
<tr>
<td>Analog Output</td>
<td>Analog Output</td>
<td>I-Have</td>
</tr>
<tr>
<td>Analog Value</td>
<td>Analog Value</td>
<td>ReadMultiple Property</td>
</tr>
<tr>
<td>Calendar</td>
<td>Calendar</td>
<td>WriteMultiple Property</td>
</tr>
<tr>
<td>Schedules</td>
<td>Schedules</td>
<td>Who-Has</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Who-Is</td>
</tr>
</tbody>
</table>

B. Programming for the system shall use BACnet objects and services. All BACnet objects and services shall be opened for read and/or read/write access during programming for future exposure to other BACnet systems. The front end software for the system shall be able to query other third party BACnet points for read/write access.

4.2 MULTIPLE OPERATING PLATFORMS

A. The front end server software furnished as a part of the DDC system shall be capable of operating on multiple operating systems such as Microsoft Windows, Linux or Sun Solaris.

4.3 GRAPHICAL PROGRAMMING

A. The system shall be programmed using a graphical programming language for ease of operator understanding. Operating sequences and logic flow shall be assembled in a schematic format using MicroBlocks representing inputs, outputs and logical functions such as setpoints, switches, limits, relays, PIDs etc. The programming software shall be furnished within this scope of work.

B. Full simulation capability shall also be provided with the graphic programming. User shall be able to fully simulate the constructed sequence on screen before the sequences are downloaded into the controllers. The system shall also include the ability to simulate multiple graphic programs communicating with each other on a simulated network.

4.4 GRAPHICAL INTERFACE SOFTWARE
A. System and Equipment Graphic User Interface:

1. The operators interface software shall be graphics based and display in 256 colors at a minimum 1024x768 pixel resolution. Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Additionally, the system hierarchy shall be displayed in a fashion similar to Windows Explorer to enable the user to navigate to any graphical screen in the system by expanding building levels or floor levels and selecting a particular zone or system. Graphics shall be accessed by using a mouse or other pointer device. The system shall provide a visual indication of which building, floor and zone the user is accessing at any time. System shall be capable of changing all parameters and schedules, as well as downloading operating software from the same Graphical User Interface software program as that used for viewing system operation.

2. Thermal graphic floor plans shall display each temperature zone in a color appropriate to current space temperature conditions. The system shall display in 8 separate colors the following conditions: High or low temperature alarm, temperature at setpoint, cooling call, heating call, more than 2° above setpoint, more than 2° below setpoint, unoccupied between setpoints and no communication. Floor plans shall also include color graphic indicators for non-zone specific mechanical equipment operation showing On/Off and Alarm Conditions. Status indication colors shall be updated dynamically as conditions change.

3. Mechanical equipment pictorial graphics shall be displayed by the use of point-and-shoot selection using a mouse or other pointer device. Graphics shall be provided for all mechanical equipment and devices controlled by the DDC system. These graphics shall provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.

B. Software Graphic Programming Live User Interface:

1. The system shall be able to display the graphic displays of system programming, operating logic and logic flow with real time conditions displayed at each input, output and logical function. This display will allow the operator to observe each step of a control logic process and facilitate system software troubleshooting. Operator shall have the ability to select any MicroBlock in the graphical program to change parameters including the ability to lock values.

4.5 FACILITY MANAGEMENT AND ENERGY MANAGEMENT FUNCTIONS

A. Scheduling:

1. The DDC system shall have the ability to schedule each individual zone, each building or floor or the entire network of buildings for any user with a single entry. Additionally, the operator shall have the capability of assembling groups of zones, buildings or floors for single entry programming, e.g. several offices may be grouped for scheduling of Saturday operations. Available
schedule types shall include normal operation, unoccupied operation, setback override and holidays. For maximum flexibility, schedules shall reside in the local control modules. Dated schedules shall be self managing and automatically delete after execution.

B. Demand Control:

1. The system shall have the ability to receive an analog or digital input of electrical usage/demand through any open input on a general purpose module. This capability shall be provided without additional hardware except the single input point and digital or analog devices required to read electrical demand levels.

2. The system will be capable of rotating greater or lower demand levels every 10 minutes to alternate zones throughout the facility to minimize long term setpoint offset.

C. Interactive Operations:

1. The system shall have the ability to send run requests, heating requests and cooling requests from one module to another for the purpose of optimizing run operations of central plant equipment. Additionally, the system shall be capable of limiting operation of various equipment if another mechanical point elsewhere in the system allows that operation. e.g. a boiler loop circulating pump shall run only when requested by a zone requiring heating operation and will shut down during hours that zone demand is satisfied.

D. Enterprise Integration:

1. The system shall be capable of exchanging web services information with other Enterprise servers for the purpose of optimizing system operation, e.g. obtaining NOAA Weather Service for optimizing Nite Flush operation, or for the purpose of providing information to other Enterprise servers to optimize other building information systems, e.g. providing maintenance notifications to an Enterprise based facilities maintenance software. The Enterprise integration software is not included within the scope of this project; however, the front end operating system shall be capable of the addition of this capability without changes to the front end software or server.

4.6 ALARMS, TRENDS AND REPORTS

A. System and Temperature Alarms:

1. The system shall have the capability of monitoring conditions throughout the system and sending alarms or messages to an e-mail address, local PC or printer or to remote PC’s, printers or to dial-up pagers. Alarms and messages shall be able to be prioritized for various levels of reporting and action. The operator shall have the ability to customize alarm text and messages.

B. Trends:
1. The system shall be capable of trending any input or output, or any logical point within the graphic program. There shall be no limitation to the number of points that can be trended at any particular time. Modules shall store in live memory 288 trend samples points for each trended item. The interval between trend samples shall be adjustable from 1 second to 24 hours. Trends from one or more modules shall be able to be simultaneously displayed on a single trend graph. Operator shall be able to “window” any segment of a trend to enlarge the view by dragging a mouse to form the “window”. The system shall also have the ability of automatically downloading trend information from any module to the server or other computer connected to the network for historical trend storage. This trend information shall be able to be displayed on the trend graph along with live current trends in seamless fashion. Trend data collection requiring the use of a locally connected PC for data storage is unacceptable.

C. Reports:

1. The system shall be capable of generating reports of equipment run times, all trended points, temperature conditions, electric demand and usage and alarms or messages. The system shall also have the ability of automatically downloading report information from any module to the server or other computer connected to the network. The operator shall have the ability to create custom report and logging formats.

PART 5 - SEQUENCES OF OPERATION

5.1 GENERAL

The following sequences of operation shall be strictly observed. All temperature setpoints, static pressure setpoints, percentage of PID output trip points and reset ratios within this specification shall be changeable by operator using the operator software furnished with the system.

5.2 DISTRIBUTED CONTROL

System shall observe the concept of distributed control. Modules shall be located at each operating equipment location such that individual systems or zones shall remain functional without communication to other systems on the network.

A. Central Plant, Pump and Fan Operation:

1. Control of all central fan systems, fluid cooler, boilers and pumping stations shall be based on run requests, heating requests or cooling requests from zone controls. Reset of supply air static pressure, supply air temperature, and water temperatures shall be based on zone temperature conditions and heating or cooling requests from zones.

B. Scheduling:

1. For maximum flexibility all occupancy schedules shall be stored in zone control modules. Central fans or pumps shall start when commanded from any associated zones that call for occupancy or
for operation to meet setback heating or cooling requirements and shall not require separate scheduling unless required for the sequence of operation. Fans or pumps shall run for minimum of 30 minutes.

END OF SECTION 230900
SECTION 260500 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Provisions of this Section shall apply to all Sections of Division 26, 27, and 28.

1.2 SCOPE OF WORK

A. Furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on the drawings and/or specified in all Sections of Division 26 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete installation, including all accessories required for testing the system. It is the intent of the drawings and specifications that all systems be complete and ready for operation.

1.3 CODE COMPLIANCE

A. All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to, the following:

1. Occupational Safety and Health Act Standards (OSHA)
2. NFPA #70 – National Electric Code (NEC)
3. ADA Standards – Americans with Disabilities Act
5. NECA – Standard of Installation
7. International Fire Code
9. NFPA #72 – Fire Code
11. All other applicable Federal, State and local laws and regulations.

B. Work to be executed and inspected in accordance with local codes and ordinances. Permits, fees or charges for inspection or other services shall be paid for by the contractor. Local codes and ordinances are to be considered as minimum requirements and must be properly executed without expense to the owner; but do not relieve the contractor from work shown that exceeds minimum requirements.

1.4 CONDITIONS AT SITE

A. Visit to site is recommended of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
B. Lines of other service that are damaged as a result of this work shall be promptly repaired at no expense to the owner to the complete satisfaction of the owner.

1.5 DRAWINGS AND SPECIFICATIONS

A. All drawings and all specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.

B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by architectural, structural and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.

C. Change to location, type, function, brand name, finish, etc., shall not be made without permission of engineer.

D. Some equipment is specifically designated on the drawings. It is not the intent to sole source any item unless explicitly stated. Items have been specified based upon design requirements. All bidders are encouraged to submit products for approval. Prior approval must be obtained as required by these contract documents. Bids submitted with non-approved items will be considered invalid and bidders will be held to provide approved materials at no additional cost to the owner. Submittals received by the engineer after award of contract on non-approved equipment will not be reviewed nor will they be returned.

E. Where conflicting direction is given within the specifications and drawings, the contractor shall include the most expensive option in the bid.

1.6 SAFETY AND INDEMNITY

A. Safety: 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 working hours.

B. No act, service, drawing review or construction review by the owner is intended to include review of the adequacy of the contractor’s safety measures in, on, or near the construction site.

1.7 CONSTRUCTION OBSERVATION BY THE ENGINEER

A. Prior to covering: any major portion of the materials installed under this section, notify the engineer so that an observation can be made. Notification shall be made at least three (3) working days in advance of the date the items will be covered.

1.8 INSTRUCTION OF OWNER’S PERSONNEL

A. The contractor shall conduct an on-site instructional tour of the entire project. The personnel designated by the owner shall be instructed in: operation of all electrical systems, trouble-shooting procedures, preventative maintenance procedures, uses of Operation and Maintenance manuals, relamping and cleaning of lighting fixtures and operation of all special systems.
B. Contractor will include in his bid 8 hours of instruction time to be held at the project location after substantial completion for instruction of owner's personnel. Coordinate time and number of owner personnel to be present and provide schedule to engineer.

1.9 PROJECT COMPLETION

A. Upon completion of all work and operational checks on all systems, the contractor shall request that a final construction observation be performed.

B. The engineer shall compile a punch list of items to be completed or corrected. The contractor shall notify the engineer upon completion of the items.

1.10 GUARANTEE

A. All work under this section shall be guaranteed in writing to be free of defective work, materials, or parts for a period of one (1) year, except lamps which shall be guaranteed for ninety (90) days, after final acceptance of the work under this contract or the period indicated under the Division 1 specifications whichever is longer.

B. Repair, revision or replacement of any and all defects, failure or inoperativeness shall be done by the contractor at no cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIAL APPROVAL

A. The design, manufacturer and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE or ANSI standards.

B. All materials must be new, unless noted otherwise, and UL listed. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency, which laboratory shall be acceptable to the owner and code enforcing agency.

2.2 SHOP DRAWINGS AND MATERIALS LIST

A. Submit shop drawings and materials lists as specified for review. Seven (7) copies, unless noted otherwise under Division 1, of submittals shall be presented to the architect/engineer.

2.3 OPERATION AND MAINTENANCE MANUALS

A. Submit four (4) sets, unless noted otherwise under Division 1, of the Operation and Maintenance Manuals of all Division 26 equipment to architect/engineer.

2.4 RECORD DRAWINGS

A. Submit record drawings to owner.
2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials in a manner to prevent damage.

B. Protect equipment from weather and dampness.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND CONTRACTOR’S QUALIFICATIONS

A. Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.

B. Provide experienced foreman with a minimum of three years experience working on this type of building placed in charge of this work at all times.

3.2 COORDINATION

A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under trades that require electrical connections. Inform contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without the authorization of the owner, shall be at contractor’s risk and expense.

3.3 MANUFACTURER’S INSTRUCTIONS

A. All installations are to be made in accordance with manufacturer’s recommendations. A copy of such recommendations shall at all times be kept in the job superintendent’s office and shall be available to the engineer.

B. Follow manufacturer’s instructions where they cover points not specifically indicated on drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the engineer before starting work.

3.4 QUALITY ASSURANCE

A. The contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

B. Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and special systems.

3.5 CUTTING AND PATCHING
A. Perform all cutting and fittings required for work of this section in rough construction of the building.

B. All patching of finished construction of building shall be performed under the sections of specifications covering these materials.

C. No joists, beams, girders or columns shall be cut by any contractor without obtaining written permission from the architect/engineer.

END OF SECTION 260500
SECTIOm 260502 – SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1: GENERAL

1.1 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or a professional licensed engineer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the current version of NFPA70E.

C. The scope of the studies shall include all distribution equipment supplied under this contract.

1.2 RELATED DOCUMENTS

A. 262413 - Main Switchboards

B. 262416 – Panelboards

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

C. The National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace
1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be submitted. For large system studies. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:

1. Executive Summary
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout
6. Details of the incident energy and flash protection boundary calculations
7. Recommendations for system improvements, where needed
8. One-line diagram
9. Arc flash labels shall be provided in hard copy.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of:

1. SKM Systems Analysis Power®Tools for Windows (PTW) software program
2. Easy Power
3. Or Pre-Approved Software.

PART 2: PRODUCT

2.1 STUDIES
A. Contractor to furnish short-circuit and protective device coordination studies as prepared by
equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical
Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the
short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the
Contractor with a listing of required data immediately after award of the contract. The Contractor shall
expedite collection of the data to assure completion of the studies as required for final approval of the
distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents
provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain
required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated
   4. Source impedance data, including electric utility system and motor fault contribution
      characteristics
   5. Tabulations of calculated quantities
   6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
   1. Electric utility’s supply termination point
   2. Incoming switchgear
   3. Low voltage switchgear
   4. Motor control centers
   5. Branch circuit panelboards
   6. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the
three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the 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 75kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc 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 a 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 calculations 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 motors 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 of 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 the 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.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d"), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated fault current magnitude and angle
   c. Fault point X/R ratio
   d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
   d. Calculated asymmetrical fault currents
      1. Based on fault point X/R ratio
      2. Based on calculated symmetrical value multiplied by 1.6
      3. Based on calculated symmetrical value multiplied by 2.7
   e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage
   b. Calculated symmetrical fault current magnitude and angle
   c. Fault point X/R ratio
d. No AC Decrement (NACD) Ratio

e. Equivalent impedance

f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis

g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 EXECUTION

3.2. ARC FLASH WARNING LABELS

A. 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.

B. 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 in the system.

C. 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.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on 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.

F. Labels shall be installed by the engineering service division of the equipment manufacture or the approved testing agencies listed in the related testing section(s).
3.3. ARC FLASH TRAINING

A. The contractor of the Arc Flash Analysis shall train the owner’s qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).

END OF SECTION 260502
SECTION 260519 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS
   A. Submit shop drawings and product data.

1.4 COORDINATION
   A. Coordinate layout and installation of cables with other installations.
   B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by the owner.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES
   A. Conductors: Stranded, copper, 600 volt insulation, type THHN/THWN, THHN/THWN-2, XHHN/XHHW.
   B. Conductors:
      1. Solid or stranded for No. 10 and smaller, stranded for No. 8 and larger, copper, 600 volt insulation, type THHN/THWN. Aluminum conductors not allowed unless noted otherwise.
      2. Insulation Types: THWN-2 for underground, THWN for wet locations, THHN for dry locations; XHHN/XHHW for GFI branch circuits and feeders fed from GFCI breakers.
   C. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
      1. Phase A: Black.
      2. Phase B: Red.
      3. Phase C: Blue.
5. Ground: Green.
6. Isolated ground: Green with yellow tracer.

D. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Brown.
2. Phase B: Orange.
3. Phase C: Yellow.
5. Ground: Green.

E. Wire connectors and splices: units of size, ampacity rating, material, type and class suitable for service indicated.

F. Signal and communication circuits:

1. Special cables as indicated on the drawings.
2. Conductors for general use: stranded copper conductor, #16 AWG minimum, with THWN-2 insulation for underground, THWN for wet locations and THHN insulation for dry locations.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Use no wire smaller than #12 AWG for power and lighting circuits and no smaller than #18 AWG for control wiring.

C. The contractor is responsible for upsizing conductor sizes to ensure the maximum voltage drop of any branch circuit does not exceed 3%. For reference, use No. 10 AWG conductor for 20 Amp, 120 volt branch circuits longer than 75 feet, and for 20 Amp, 277 volt branch circuits longer than 200 feet.

D. Place an equal number of conductors for each phase of a circuit in the same raceway or conduit.

E. Splice only in junction or outlet boxes.

F. Neatly train or lace wiring inside boxes, equipment, and panelboards.

G. Make conductor lengths for parallel circuits equal.

H. Provide a separate neutral conductor for each ungrounded conductor. Ungrounded conductors may share a neutral when all of the following conditions are met:

1. The ungrounded conductors are connected to a multi-pole breaker or breakers that are clipped together with a UL listed means that provide a common trip.
2. The ungrounded conductors contained in the same conduit or raceway.
3. The ungrounded conductors all originate from a separate and unique phase bus in the panel.
3.2 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions, and the “National Electrical Installation Standards” by NECA.

B. Remove existing wires from raceway before pulling in new wires and cables.

C. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables above accessible ceilings; do not rest on ceiling tiles. Do not fasten cables to ceiling support wires. Use cable ties to support cables from structure.

3.3 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and tap connectors compatible with conductor material.

D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

F. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values.

G. Terminate spare conductors with electrical tape.

3.4 LABELING

A. Provide Brady wire markers or equivalent on all conductors. All wire shall be labeled in each box and panel with the circuit number and panel identification.

3.5 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage.

B. Perform continuity testing on all power and equipment branch circuit conductors. Verify proper phasing connections.

END OF SECTION 260519
SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including Fixed Price Construction Contract and
      Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in
      this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SYSTEM DESCRIPTION
   A. Ground the electrical service system neutral at service entrance equipment to concrete encased electrode,
      metal underground water pipe, and effectively grounded metal frame of building.
   B. Ground each separately-derived system neutral to nearest effectively grounded metal structural frame of
      building or point of service entrance ground.
   C. Provide communications system grounding conductor to point of service entrance ground.
   D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of
      electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle
      ground connectors, and plumbing systems.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS
   A. For insulated conductors, comply with Section 260519 - Conductors and Cables.
   B. Material: Copper.
   C. Equipment Grounding Conductors: Insulated with green-colored insulation. Where green insulation is not
      available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction
      box or device enclosure.
   D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow tracer. Where not
      available, green and yellow tape at each junction box or device enclosure.
   E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
F. Bare Copper Conductors: Medium hard drawn copper conductor, stranded, sized as shown on the drawings.

G. Hardware: Bolts, nuts and washers shall be bronze; cadmium plated steel or other non-corrosive material, approved for the purpose.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.2 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer’s written instructions.

D. Below grade compression fittings: Thomas & Betts, Series 52000, 53000, and 54000 or equivalent.

E. Use connector and sealant approved for purpose on all below grade clamp or compression type connections.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

   1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NEC Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.

B. Install equipment grounding conductors in all feeders and circuits.
C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways bonded to outlet or equipment, sized per Section 250 of the NEC.

G. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, 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.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.4 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.
   5. 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. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. 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 non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer’s published torque-tightening values.

F. 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.

G. 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.

3.5 SYSTEM NEUTRAL GROUND

A. Ground the neutral conductor of each transformer or generator to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.

B. Ground generators or transformers with secondary voltage 600 volt or less as follows:

   1. 3 phase, 4 wire Wye connected: ground neutral point

C. For transformers 75 kVA or smaller with primary voltage 480 volt or less the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with NEC system ground conductor size.

3.6 EQUIPMENT GROUND

A. Ground non-current carrying metal parts of electrical equipment enclosures, frames, conductor raceways or cable trays to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Install a grounding conductor in each raceway system. Equipment grounding conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size grounding conductors per NEC 250 unless otherwise shown on the drawings.

B. Install metal raceway couplings, fittings, and terminations secure and tight to ensure good grounding continuity. Provide grounding conductor sized per NEC through all raceway and conduit systems.

C. Lighting fixtures shall be securely connected to equipment grounding conductors. Outdoor lighting standards shall have a factory installed ground lug for terminating the grounding conductor.

D. Motors shall be connected to equipment ground conductors with a bolted solderless lug connection on the metal frame.
3.7 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS
   A. EMT: Electrical metallic tubing.
   B. FMC: Flexible metal conduit.
   C. IMC: Intermediate metal conduit.
   D. LFMC: Liquidtight flexible metal conduit.
   E. RMC: Rigid metal conduit.
   F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS
   A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 COORDINATION
   A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING
   A. Rigid Steel Conduit: ANSI C80.1.
   B. IMC: ANSI C80.6.
C. PVC coated Steel Conduit and Fittings: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal two mil urethane coating.

D. EMT and Fittings: ANSI C80.3. Fittings: Set-screw type.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.2 NONMETALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Schedule 40 PVC. Fittings: NEMA TC 3; match to conduit and material.

2.3 METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include covers, 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.

C. Finish: Manufacturer’s standard enamel finish.

2.4 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

2.5 FLOOR BOXES

A. Floor Boxes: Cast metal, fully adjustable, rectangular, unless otherwise specified.

2.6 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1, 3R, or 4, with continuous hinge cover and flush latch, key operable.

1. Metal Enclosures: Steel, finished inside and out with manufacturer’s standard enamel.
B. 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.

2.8 J-HOOKS

A. J-hooks: Steel, rated for indoor use in non-corrosive environments. J-hooks shall be rated to support Category 5e cable.

B. Fittings and Support Bodies: Manufacturer’s recommended fittings including side mount flange clips, bottom mount flange clips, beam clamp, rod and flange clip, C & Z purlin clip, and all other components and assemblies to make the system work.

C. Acceptable Product: Caddy CableCat Hanging System, 1-5/16” and 2” hooks, or approved equal

D. Acceptable Manufacturer: Erico Fastening Products or approved equal.

E. J-hook Supports: Manufacturer’s recommended fastening devices.

2.9 INNERDUCT

A. Innerduct: NEMA TC 5. UL Listed, corrugated, specifically designed for optical fiber cable pathways.

B. Acceptable Manufactures: Arnco, Carlon, Dura-line, and Pyramid.

C. Composition:
   1. Non-plenum rated: Polyethylene (PE), or High Density Polyethylene (HDPE).
   2. Plenum rated: per manufacturer.

D. Nominal Size: 1” (inside diameter), minimum.

E. Pulling Strength: minimum of 600 pounds.

F. Color: Orange, solid.

G. Fittings and Innerduct Bodies: Manufacturer’s recommended fittings including couplings, adapters, end caps, end bells, expansion couplings, plugs, sleeves, a full compliment of connective devices, and all other components to make the system work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
4. Underground, Grouped: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Indoors: Use the following wiring methods:

1. Exposed: EMT or “Wiremold” metallic raceways or equal.
2. Exposed in public areas: “Wiremold” metallic raceways or equal. Use of exposed raceways in public areas must be approved by the architect prior to installation for each location. Use of exposed EMT in areas visible to the public is not allowed unless specifically approved by the architect prior to installation. Replacement of unapproved installations of exposed raceways will be at the expense of the contractor if deemed necessary by the architect or engineer.
3. Concealed: EMT, MC-Cable, Hospital Grade MC-Cable for all Patient Care Areas. Note: MC-Cable is not approved for “homeruns”
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
5. Damp or Wet Locations: Rigid steel conduit.
6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
   a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer’s written instructions.

B. Minimum Raceway Size: 1/2-inch trade size. 3/4-inch minimum for “homeruns”.

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

D. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

H. Use temporary closures to prevent foreign matter from entering raceways.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

M. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Transition from nonmetallic tubing to rigid steel conduit or IMC before rising above floor.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
   1. Run parallel or banked raceways together, on common supports where practical.
   2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.
   1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
   2. Use insulating bushings to protect conductors.

P. Tighten set screws of threadless fittings with suitable tools.

Q. Terminus: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

R. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

S. Install pull wires in empty raceways. Utilize polyester line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

T. Telephone and Signal System Raceways: In addition to the 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.

U. Install raceway sealing fittings according to manufacturer’s written instructions. Locate 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 the boundaries of refrigerated spaces.
2. Where conduit pass from the interior to the exterior of a building.
3. Where otherwise required by NEC.

V. Apply firestopping to cable and raceway penetrations of fire-rated floor, ceiling, and wall assemblies to achieve fire-resistance rating of the assembly. Boxes installed in fire-rated floor, ceiling, and wall assemblies shall result in no larger than a 16 square-inch penetration in the fire-rated wall surface and the quantity of penetrations shall not be greater than 100 square-inches for every 100 square feet of fire-rated wall area. Where boxes are located on both sides of a fire-rated wall, the boxes shall have a minimum of a 24" horizontal spacing, where a 24" horizontal spacing cannot be achieved, furnish and install listed fire-rated putty on the boxes as required by the IBC.

W. Route conduit through roof openings for piping and ductwork where possible; otherwise, install roof penetrations in accordance with roofing system requirements. Coordinate with roofing installer.

X. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

Y. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

Z. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

AA. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.

BB. Conduits shall not be routed on or above the roof without prior approval from the Engineer. Instead, the branch circuits shall be routed at the structure level below the roof to feed roof-top equipment. When approval is granted to route conduits on or above the roof, the conduits shall be strapped to COOPER industries DB series support blocks at intervals not exceeding NEC requirements. The conduits shall not be rested directly on the roof. It shall be permissible to penetrate the roof adjacent mechanical or electrical equipment to power that respective equipment.

3.4 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers, at least every 8 feet.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
F. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards; disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Perform fastening according to the following unless other fastening methods are indicated:

1. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
2. New Concrete: Concrete inserts with machine screws and bolts.
3. Existing Concrete: Expansion bolts.
4. Steel: Spring-tension clamps on steel.
5. Light Steel: Sheet-metal screws.
6. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

N. Do not drill structural steel members.

O. All supports and attachments shall meet project seismic zone requirements.

3.5 BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

B. Locate boxes in masonry walls to require cutting of masonry unit edge only. Coordinate masonry cutting to achieve neat openings for boxes.

C. Provide knockout closures for unused openings.

D. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.
E. Use 4" boxes with multiple-gang mudring where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

F. Install boxes in walls without damaging wall insulation.

G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

H. Position outlets to locate lighting fixtures as shown on reflected ceiling plans.

I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

J. 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 outlets in hollow stud walls, and adjustable steel channel fasteners for flush ceiling outlet boxes.

K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

L. For boxes installed in metal construction, use rigid support metal bar hangers or metal bar fastened to two studs or with metal screws to metal studs.

M. Set floor boxes level and adjust to finished floor surface.

N. Set floor boxes level and trim after installation to fit flush to finished floor surface.

O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

P. Locate pull and junction boxes above accessible ceilings or in unfinished areas. Support pull and junction boxes independent of conduit.

Q. Minimum box size to be 4" square by 2 1/8" deep.

3.6 LABELING

A. Label coverplate of all pull and junction boxes by system served. Indicate panel circuits for power and lighting boxes.

3.7 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533
SECTION 260536 - CABLE TRAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes cable trays and accessories.

1.3 SUBMITTALS
   A. Submit shop drawings, product data, manufacturer’s installation instructions and maintenance manuals.

1.4 COORDINATION
   A. Coordinate layout and installation of cable tray with other installations.
      1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 CABLE TRAYS
   A. Steel, 4 inch deep, width as indicated on the drawings, basket type.
   B. Fabricate cable tray products with rounded edges and smooth surfaces.

2.3 CABLE TRAY ACCESSORIES
   A. Fittings: Tees, crosses, risers, elbows, and other fittings as required, of same materials and finishes as cable tray, to form a continuous cable tray system.
   B. Barrier Strips: Where indicated on the drawings; same materials and finishes as cable tray.
C. Cable tray supports and connectors as recommended by cable tray manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cable tray in accordance with manufacturer’s written instructions.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports securely to building structure as specified.

D. Install expansion connectors where cable tray crosses a building expansion joint and in cable tray runs that exceed 90 feet.

E. Make changes in direction and elevation using standard fittings.

F. Make cable tray connections using standard fittings.

G. Workspace: Install cable trays with sufficient space to permit access for installing cables.

3.2 CLEANING

A. On completion of cable tray installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

END OF SECTION 260536
PART I - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this Section.

1.2 SUMMARY:

A. This Section includes requirements for commissioning the lighting system and its controls.

B. The registered design professional is responsible to provide evidence of lighting systems commissioning and completion in accordance to the provisions of this section.

1.3 DEFINITIONS:

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. RDP: Registered Design Professional

C. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean “as-built” systems, subsystems, and equipment.

1.4 COMMISSIONING DOCUMENTATION:

A. Commissioning Plan: A commissioning plan will be developed by a registered design professional or approved agency and shall include the following items:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.

2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.

3. Functions to be tested.

4. Conditions under which the test will be performed.

5. Measurable criteria for performance
B. Test Checklists: RDP, with assistance of Architect/Engineer, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist.

1. Name and identification of tested item.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Date of the test and name of parties involved as applicable.
6. Individuals present for test.
8. Note if re-test is necessary.

C. Test and Inspection Reports: RDP shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. RDP shall compile test and inspection reports and tests and inspection certificates and include them in systems manual and commissioning report.

D. Corrective Action Documents: RDP shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

E. Issues Log: RDP shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.

1. Creating an Issues Log Entry:
   a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
   b. Assign a descriptive title of the issue.
   c. Identify date and time of the issue.
   d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
   e. Identify system, subsystem, and equipment to which the issue applies.
   f. Identify location of system, subsystem, and equipment.
   g. Include information that may be helpful in diagnosing or evaluating the issue.
   h. Note recommended corrective action.
   i. Identify commissioning team member responsible for corrective action.
   j. Identify expected date of correction.
   k. Identify person documenting the issue.
2. Documenting Issue Resolution:
   a. Log date correction is completed or the issue is resolved.
   b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
   c. Identify changes to the Contract Documents that may require action.
   d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
   e. Identify person(s) who corrected or resolved the issue.
   f. Identify person(s) documenting the issue resolution.

3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, RDP shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, RDP shall include the following information in the issues log and expand it in the narrative:
   a. Issue number and title.
   b. Date of the identification of the issue.
   c. Name of the commissioning team member assigned responsibility for resolution.
   d. Expected date of correction.

F. Commissioning Report: RDP shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.

2. Commissioning plan.

3. Testing plans and reports.

4. Corrective modification documentation.

5. Issues log.

6. Completed test checklists.

G. Systems Manual: RDP shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:

1. Submittal Data stating equipment installed and selected options for each piece of equipment requiring maintenance.

2. Operation and maintenance data on each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
3. Name and address of at least one service agency.

4. Lighting controls system maintenance and calibration information.

5. A narrative of how each system is intended to operate, including recommended setpoints.

PART 2 – PRODUCTS – Not Used

PART 3 - EXECUTION

3.1 TESTING:

A. Testing shall ensure that the control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturers installation instructions.

B. Testing shall ensure that the lighting controls meet all provisions of the applicable energy code.

C. Perform tests using design conditions whenever possible. Where occupant sensors, time switches, programmable schedule control, photosensor’s or daylighting controls are installed, the following procedures shall be performed:

1. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.

2. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.

3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified.

END OF SECTION 260800
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.
B. Related Sections include the following:
   1. Section 262726 - Wiring Devices for wall-box dimmers and manual light switches.

1.3 SUBMITTALS

A. Submit shop drawings and product data, including all wiring diagrams.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS


2.2 TIME SWITCHES

A. Description: Electromechanical-dial type complying with UL 917.
   1. Astronomical dial.
   2. Two contacts, rated 30 A at 277-V ac, unless otherwise indicated.
   3. Eight-day program uniquely programmable for each weekday and holidays.
   4. Skip-day mode.

2.3 LIGHTING CONTROL SYSTEM

A. Description of Work: Extent of lighting control system work is indicated by drawings, and by the requirements of this section. It is defined to include low voltage lighting control panels, switch inputs, and wiring.
1. Type of lighting control equipment and wiring specified in this section include the following:
   Low Voltage Lighting Control Panels.

B. SYSTEM DESCRIPTION

1. The lighting control system shall consist of low voltage relay control panels with 32 programmable switch inputs and shall offer 32 control relays.
2. Each low voltage lighting control panel shall be microprocessor controlled with an integral 4 x 16 - 64 character display and with a programming keypad.
3. Programmable intelligence shall include Time-Of-Day control, 32 holiday dates, warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control.

<table>
<thead>
<tr>
<th>TOD</th>
<th>64 Time-Of-Day/holiday schedules for 365 day programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holidays</td>
<td>32 holiday dates</td>
</tr>
<tr>
<td>Warn Off</td>
<td>Flash lights and provide an extra 1 second to 99 minutes of illumination</td>
</tr>
<tr>
<td>Preset</td>
<td>Pre-programmed switch patterns</td>
</tr>
<tr>
<td>Timed Inputs</td>
<td>Switch input timers 1-999 minutes</td>
</tr>
<tr>
<td>Timed Overrides</td>
<td>Timed override 1-999 minutes, resumes to normal schedule</td>
</tr>
<tr>
<td>Local Control</td>
<td>From alpha-numeric keypad &amp; local switch</td>
</tr>
<tr>
<td>Astronomical</td>
<td>Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting Clock</td>
</tr>
<tr>
<td>Auto Daylight</td>
<td>Automatically adjusts the clock at the appropriate dates, selectable Savings Adjust.</td>
</tr>
<tr>
<td>Priorities</td>
<td>Establishes a hierarchy for inputs and network control commands</td>
</tr>
<tr>
<td>Masking</td>
<td>Provides permission orientation to switch inputs and network commands thereby ensuring building lighting control integrity.</td>
</tr>
<tr>
<td>Soft-Linking</td>
<td>Group linking for rapid programming</td>
</tr>
</tbody>
</table>

4. Relays may be designated as either normally open or normally closed from software. Relay status shall not only disclose commanded relay status but next scheduled state to occur.
5. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending Off command. The Warn Off command shall provide an adjustable time duration of 1 second to 99 extra minutes. The occupants may exit the premises with adequate lighting or cancel the Warn Off by overriding the lighting zone. This option occurs with all Off commands except local overrides.
6. The controller shall permit lighting to be overridden on for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state. Also, the controller shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements. These overrides shall be hard-wired inputs.

7. Programming the controller shall be through the local integral keypad. Descriptive information shall assist the user to employ the system without a programming manual.

8. Priorities and/or Masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on Time-Of-Day scheduling in the controller. Masks shall permit: On only, Off only and On & Off control for intelligent after hours utilization of the controlled facility.

9. The lighting control system may be fully programmed through PC programming software. Programming shall be permitted through a direct RS-232 or RS-485 connection, and modem.

C. HARDWARE FEATURES

1. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of a circuit board mounted keypad capable of linking switch inputs to relay outputs and schedule assignments. Systems that utilize blocking diode technology for relay assignments shall not be acceptable.

The integral keypad shall provide access to the main programming features. The keypad shall permit the user to manually command any or all relays individually. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted.

2. Contact inputs: The control system shall permit 32 dry contacts (Digital/Switch Inputs) for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Maintained contacts shall be supported as 2 wire (SPST) inputs. Inputs shall be dry contacts (24 VDC @ 12 ma. internally supplied to the inputs). An input shall be software linked to any number of relays for override control.

The controller shall provide timers for each switch input. Each switch input timer shall be capable of 0-999 minutes. Software shall enable or disable switch inputs based on Time Of Day scheduling.

3. Relay Type: The system shall utilize control relays which are rated to 20 amps at 277 VAC. The relays shall be magnetically held and are provided in groups of eight. Relays that are latched or mechanically held are not acceptable. The relays shall be rated for 10 million mechanical operations. A limited 10 year warranty shall be provided on the individual relays.

4. Photocell Control: The controller shall accept user adjustable ambient light sensors. The controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for both outdoor and indoor applications and provide a dry contact to the controller once the threshold is reached. The sensor shall provide user adjustable dead band control.

5. Modular Design: The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on quick release hinge pins that shall permit an entire change out of the processor and input board in less than 1 minute.
All connections for the switch inputs shall incorporate modular connectors. The relay
board shall be modular and designed for rapid field replacement or upgrading. Systems
that do not employ modular connectors shall not be acceptable.

6. Hardware Output Options
   a. Latching Relay Card (LRC): The controller shall provide an option for remote
      placement of the control relays. A modular card shall connect into the relay
      compartment. Twisted (3) conductor cable shall power and control the remote
      mounted relays. Maximum distance is 500 feet employing 18 AWG conductor.
   b. Modular Relay Card (MRC): The controller shall provide an option for modular
      relay control. The Modular Relay Card (MRC) shall offer the feature of
      controlling two pole voltages such as 208, 240, and 480VAC in a Normally Open
      or Normally Closed configuration. Single pole is offered for 120 and 277VAC in
      a Normally Open and Absolute Zero Configuration. This relay card shall also
      provide visual indication of relay status. Relays shall be individually exchangeable
      with plug in low voltage connectors. Combinations of relays shall be permitted
      since relay modules shall snap into and lock in location. Two pole modules
      require two relay locations for a maximum of four two pole relays per card. All
      other relay modules use 1 relay location for a maximum of eight per card. All
      Modular Relay Card components shall be warranted for 10 years.
   c. Two Pole Relay Card (TPRC): The controller shall provide an option for two
      pole relay control. The Two Pole Relay Card TPRC shall offer the feature of
      controlling two pole voltages such as 208, 240, and 480 VAC lighting loads at 20
      amps. The relays shall be modular in design and offer manual hand override
      control. This optional relay card shall also provide a visual indication of relay
      status. The 208, 240 VAC version shall provide 8 relays per card whereas the
      480 VAC version shall provide 4 relays per card. Combinations of relays shall be
      permitted since relays shall snap into location.
   d. Automatic Relay Card (ARC): The system shall utilize hybrid control relays that
      are rated to 20 amps at 277 VAC. The hybrid relay shall combine a high speed
      electronic switch with a mechanical relay to create a unique switching device.
      The hybrid design shall look at each AC phase and shall close the electronic
      switch precisely at the absolute zero crossing. The mechanical relay in parallel
      shall follow and close after the in-rush current condition. The relay shall provide
      an integral switch for both manual hand operation and visual indication of relay
      status. The relays shall be rated for 10 million mechanical operations. A limited
      2 year warranty shall be provided on the individual relays.
   e. Lighted Switch Card (LSC): The controller shall provide an option for pilot light
      wall switch annunciation. A modular card shall connect into the controller board
      and shall provide power to illuminate pilot light switches. This option shall
      confirm relay operation. When a relay is in the "ON" position the pilot light
      switch shall be illuminated.

7. Diagnostic Aids: Each control panel shall incorporate diagnostic aids for confirmation of
   proper operation, or in case of failure these aids shall guide the individual in rapid
   troubleshooting of the system.

   The control panels shall employ both a backlit super-twist LCD and LED’s that indicates:
   - POWER (LED)
   - SYSTEM OK (LED)
   - NETWORK COMMUNICATIONS (LED)
   - ON/OFF STATUS of EACH RELAY (LED & LCD)
   - SYSTEM CLOCK and DATE (LCD)
   - PROGRAMMING CONFIRMATION (LCD)
     (TOD, HOLIDAY, ON/OFF, & PRESET)

   Control systems that do not provide visual self help diagnostics shall not be acceptable.
8. Memory Back-up: The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in RAM shall be protected against power interruptions lasting as long as 7 days. The power interrupt protection circuit shall be entirely maintenance-free.

9. Multi-tapped Transformer: The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltages of 120 & 277 VAC shall be available with each control panel.

10. Status Indication of Relays: The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose On/Off status and relay number.

11. Service Override & Priority Override: The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior.

The master service override provides a single three position switch with the option of All Off, Auto, and All On, respectively. This master switch shall operate all of the relays in the controller. This switch shall override and supersede all commands from the logic board when the switch is in the All On or All Off position. The master switch shall function to override all the relays should the logic board programming differ from the space function.

The system shall remember the last command to the individual relays. Upon returning the master override switch to the Auto position, the relays shall return to the most recent command state. This will occur even if the last command happened during the master override condition.

Additionally, the system shall provide external priority override for the entire panel. Through an externally maintained contact the override card shall place the panel in a priority state. This external contact will supersede any other programmed state and will command all the relays ON or OFF depending on operational choice. This priority state will continue until the external contact is removed. Once the external override is removed the control panel will return the relays to the appropriate programmed state.

12. Lockable Enclosure: Each control panel shall be enclosed in a lockable NEMA class 1 enclosure. The enclosure shall be manufactured out of 1/16" steel and shall provide pre-punched knockouts for efficient installation.

13. Panels: The low voltage controller shall exist in two sizes of relay enclosures. The enclosure maximum sizes shall be 32 relays per cabinet. The 16 size will employ two relays cards and the 32 will utilize 4 relay cards. Relays shall be provided in groups of eight relays per card.

14. High Voltage Barriers: The low voltage controller shall provide as an option the ability to provide a barrier for either voltage separation or emergency circuit separation. The 16-size enclosure shall permit one barrier and the 32-size enclosure shall permit up to three locations where the barrier(s) may be installed. The barrier shall be painted red to denote the difference.

15. Modem: The control system shall be capable of modem communications. Each control panel shall provide a serial communications port for external tele-communications. The modem shall utilize the Hayes compatibility standard and enable modem access as defined by the Bell 212A and CCITT V.22 protocol standards.

16. Telephone Overrides (TIM): The control system shall provide intelligent software for the Telephone Interface Module (TIM) option. The optional TIM unit shall allow modem communications and touch tone overrides from any touch tone phone. The control system shall be multi-tasking and permit up to one TIM for each control panel.
Override Operation: Touch-tone interface shall permit the control panel to command pre-assigned control points On\Off. All user interfaces shall be through the twelve Touch-tone keys on the telephone. All entries into the override system shall be prompted by a digitized voice. Systems not employing voice guided override instruction are not acceptable.

The TIM shall provide individual control passwords. Each password shall allow a preset group designation (number of relays) and the duration of the telephone override. TIM shall also provide a password to prevent entry into the override control system.

17. Software: System provided shall include the manufactures PC based interface software package. The PC based interface software shall provide access to lighting control system files within a Microsoft Windows environment. The software package shall allow individual panel programming to be executed locally, direct connection, Ethernet connection or remotely through a modem. The central programming software shall permit the user to modify the control panel programming or configuration in an "OFF-LINE" mode. This software package shall store all programmed data and archive for future use. Systems using third party software are not acceptable.

The following features shall be standard in the PC based software:

a. Standard Software Features:
   i. Real Time Relay Status Monitoring
   ii. Alpha-Numeric Descriptors
   iii. Communications: Direct, Network, Ethernet and Modem
   iv. Network Status Indication
   v. Global Software Modifications
   vi. Manual Relay Commands
   vii. Remote Pattern Commands
   viii. Preset Options

b. File Maintenance
   i. Archive Programs
   ii. Data Base Restoration
   iii. Uploading and Downloading of Programs

Software package shall permit the PC to be utilized for other functions (i.e. word processing, data-base, & etc..) besides lighting control. Systems that require an "on-line" dedicated computer for control system operation shall not be acceptable.

18. PC Interface (RS-232 port): The controller shall permit PC programming through software. The controller shall provide a RJ-12 connection for RS-232 programming. Programming shall be permitted through either a local connection or remotely through a modem. PC software shall permit multiple file storage for data archival and for seasonal facility requirements. Operator commands may be issued directly from the PC keyboard.

D. MANUFACTURERS

1. Cooper Controls, Greengate
2. Lutron
3. Lighting Control & Design
4. Lightolier

E. PRODUCT SUPPORT AND SERVICE
1. Factory Support: Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

F. WARRANTY

1. Manufacturer shall supply a 2 year warranty on all hardware and software. A limited 10 year warranty shall be provided on the standard relay card.

2.4 PHOTOELECTRIC RELAYS

A. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A.

B. Light-Level Monitoring Range: 0 to 3500 fc, with an adjustment for turn-on/turn-off levels.

C. Time Delay: Prevents false operation.

D. Outdoor Sealed Units: Weather tight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

2.5 OCCUPANCY SENSORS

A. Occupancy sensors indicated on the plans are to establish room controls and sensor quantities. The contractor is to verify sensor placement with the local manufacturer’s representative or the manufacture to ensure proper coverage and functionally of the specific sensor(s) installed. The contractor is to return and make any adjustments necessary to the occupancy sensor settings and/or placement needed to maintain proper functionality within 30 days after the owner/tenant takes occupancy of the project.

B. Lighting control system shall include all occupancy sensors, power packs, and control wiring required to form a complete system.

C. All occupancy sensors shall be dual/multi technology, manufactured by Unenco, Wattstopper, Lightolier Controls, Sensor Switch, or pre-approved equal unless otherwise noted.

D. Ceiling and Wall Mount Units: Shall utilize dual/multi technology detection methods. Unit receives control power from a separately mounted auxiliary power and control unit, and operates power switching contacts in that unit.

E. Switch-Box-Mounting Units: Shall utilize dual/multi technology detection methods. Unit receives power directly from switch leg of the 120- or 277-V ac circuit it controls and operates integral power switching contacts. Unit is to have integral manual controls and is to be mounted at standard switch height.

F. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.

1. Time Delay for Turning Lights Off: Adjustable over a range from 1 to 30 minutes, minimum. Time delay to be set at 20 minutes unless otherwise directed. Contractor shall verify time delay with the owner/tenant prior to final occupancy.
2. Manual Override Switch: Where indicated on drawings; turns lights off manually regardless of elapsed time delay.

3. Sensor shall be located and/or adjusted to detect occupancy within 1-foot of entry into room or area controlled by the occupancy sensor.

G. Auxiliary Power and Control Units: As follows:

1. Relays rated for a minimum of 20-A normal ballast load.
2. Sensor Power Supply: Rated to supply the number of connected sensors.
3. Relays shall have an auxiliary contact(s) for integration with HVAC or other building control systems.

H. Passive-Infrared Type: Detects occupancy by a combination of heat and movement in zone of coverage.

I. Ultrasonic Type: Emits a beam of ultrasonic energy and detects occupancy through use of Doppler's principle in discerning movement in zone of coverage by sensing a change in pattern of reflected ultrasonic energy. Ultrasonic frequency shall be 25 Khz or greater and sensor shall be temperature and humidity resistant.

J. Dual-Technology Type: Uses a combination of passive-infrared and ultrasonic or microphonic detection methods to distinguish between occupied and unoccupied conditions for area covered. Particular technology or combination of technologies that controls each function (ON or OFF) is selectable in the field by operating controls on unit.

K. All sensors shall be capable of operating normally with electronic ballast and compact fluorescent systems.

L. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

M. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.

N. In the event of failure, a bypass manual “override on” feature shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly. The override feature shall be designed for use by building maintenance personnel and shall not be readily accessible by building occupants.

O. All sensors shall provide an LED indication light to verify that motion is being detected and that the unit is working.

P. All sensors shall have no leakage current in OFF mode and shall have voltage drop protection.

2.6 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and mechanically held, and complying with UL 508 and NEMA ICS 2.

1. Current Rating for Switching: UL listing or rating consistent with type of load served.
2. Control Coil Voltage: Match control power source.
3.1 INSTALLATION
   A. Install equipment level and plumb and according to manufacturer’s written instructions.

3.2 CONTROL WIRING INSTALLATION
   A. Install wiring between sensing and control devices according to manufacturer’s written instructions.
   B. Wiring Method: Install all wiring in raceways.
   C. Bundle, train, and support wiring in enclosures.
   D. Ground equipment.
   E. Connections: Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values.

3.3 IDENTIFICATION
   A. Provide Brady wire markers or equivalent on all conductors.

3.4 FIELD QUALITY CONTROL
   A. Inspect control components for defects and physical damage.
   B. Verify settings of photoelectric devices with photometer.
   C. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer’s written instructions:
      1. Continuity tests of circuits.
      2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
   D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
   E. The Lighting Control Panel shall be tested and listed under the UL 906 Energy Management Equipment Standards.

3.5 CLEANING
   A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

END OF SECTION 260923
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panelboards.
2. Distribution panelboards.

B. Related sections:
1. Section 260526 - Grounding.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective 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. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. Enclosure types and details for types other than NEMA 250, Type 1.
   b. Bus configuration, current, and voltage ratings.
   c. Short-circuit current rating of panelboards and overcurrent protective devices.
   d. UL listing for series rating of installed devices.
   e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Maintenance Data: For panelboards and components, 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.

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA PB 1.

C. Comply with the NEC.

1.5 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, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Panelboards, Overcurrent Protective Devices and Accessories:
   c. Siemens
   d. Square D Co.; Schneider Electric Brands
   e. Or approved equal.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush or surface mounted cabinets (as indicated on drawings). Construct cabinets with code gauge galvanized steel. Provide minimum 20” wide cabinets and extra wiring space where incoming feed-through or parallel lines are shown. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

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

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Doors: Provide door-in-door construction, made of cold-rolled steel. Inner door shall provide access to breaker handles and outer door shall provide access to wiring space as well. Inner door shall be completely flush with no visible bolts, screw-heads or hinges and with flush catch and lock. Outer door shall have concealed hinges, flush catch and lock to match inner door, located in line with inner door catch. (Tee bar handles are not acceptable).

D. Finish: Manufacturer’s standard enamel finish over corrosion-resistant treatment or primer coat.
E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity. Attach circuit breakers to bus so that circuits 1, 3, and 5; 2, 4, and 6, or any three similarly numbered circuits form one three-phase, four-wire circuit.

G. Main and Neutral Lugs: Compression or mechanical type suitable for use with conductor material.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

J. Isolated Equipment Ground Bus: Where indicated on drawings - Adequate for branch-circuit equipment ground conductors; insulated from box.

K. Extra-Capacity Neutral Bus: Where indicated on drawings, neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Where indicated on plans, On 120/208Y Panels fed by K factor Type Transformer.

L. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor. Where indicated on plans.

M. Gutter Barrier: Arrange to isolate individual panel sections.

N. Feed-through Lugs: Compression or mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device. For two-section panels.

O. Panels located adjacent to each other shall have identically sized enclosures and trims.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating. If not series rated: Fully rated to interrupt symmetrical short-circuit current available at terminals or the rating indicated on the plans, whichever is higher.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices:
   1. 120/208Y volt branch circuit panelboards: Quick-make, quick-break, molded case plug-in type designed for 120/208Y volt, three-phase, four-wire service with minimum 10,000 amperes rms short circuit rating.
   2. 277/480Y volt branch circuit panelboards: Molded case bolt-on type designed for 277/480Y volt, three-phase, four-wire service with minimum 14,000 amperes rms short circuit rating.
   3. Provide multi-pole units with common trip elements.
   4. Breaker shall have center-tripped position in addition to the ON and OFF positions.
   5. Provide lockouts for all circuits that should not be inadvertently tripped (as indicated on the drawings).
2.5 DISTRIBUTION PANELBOARDS

A. Dead-front, dead-rear, Nema 1 or 3R enclosure as indicated, designed for use on a three-phase, four-wire, 120/208Y or 277/480Y volt system. See drawings for additional details.

B. Construction: Code gauge galvanized steel fully flanged for strength and rigidity. Door and trim shall be cold-rolled steel, code gauge. Provide concealed butt hinges and 3-point catch and lock. Provide separately hinged or bolted vertical access doors over lug and wiring spaces.

C. Bus Bars: Panel shall be fully bussed. Shall be used throughout and shall be hard-rolled, electrolytic copper of 98% conductivity designed for a maximum 1000 amperes per square inch. Bars shall be factory pre-drilled to accept future field installation of 2 or 3 pole circuit breakers in any combination. Brace all bus bars for required short circuit rating of the panel, but in no case less than 35,000 amperes rms. Refer to Short Circuit information above for additional requirements.

D. Main Overcurrent Protective Devices: Circuit breaker unless otherwise noted.

E. Provide handle locking devices for all circuit breakers.

F. Provide engraved nameplates with minimum ¼” high letters secured to panel front and for each circuit protective device in panel.

2.6 OVERCURRENT PROTECTIVE DEVICES

B. Feeder Circuit Breaker Assemblies 400 Amps or larger:

1. Feeder Circuit breakers 400 Amps or larger shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for overcurrent and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:

   a. UL listed for 80 percent load application unless otherwise indicated on plans.
   b. Long time pickup (ampere setting) determined by interchangeable rating plug.
   c. Adjustable instantaneous with short time tracking function.
   d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
   e. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position

2. Where specifically indicated or required by NEC

   b. Adjustable [S] Short time-delay and pick-up.
   c. Adjustable [I] Instantaneous trip.
   d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
   e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
   f. Short circuit, overload and ground fault trip indicators.
   g. Trip device of circuit breakers shall be of same type for tripping coordination.

C. Feeder Circuit Breaker Assemblies 150 Amp and below:
1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker: Inverse time Current element for low level overloads, and instantaneous magnetic trip element for short circuits, unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:
   a. UL listed for 80 percent load application unless otherwise indicated on plans.
   b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
   c. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position.

2. Where specifically indicated or required by NEC
   a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
   b. Adjustable [S] Short time-delay and pick-up.
   c. Adjustable [I] Instantaneous trip.
   d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
   e. Where indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
   f. Short circuit, overload and ground fault trip indicators.
   g. Trip device of circuit breakers shall be of same type for tripping coordination.

D. General Breaker Requirements:
   1. Minimum interrupting capacity shall match the minimum required interrupt rating of the panel.
   2. Standard frame sizes, trip ratings, and number of poles.
   3. Lugs: Mechanical or compression style, suitable for number, size, trip ratings, and material of conductors.
   4. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
   5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Clearances: Minimum code required clearances around panelboards must be maintained.

C. Mounting Heights: Top of trim 78 inches above finished floor, unless otherwise indicated.

D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Mounting Hardware: Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column or other parts of building structure.
F. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

G. Install filler plates in unused spaces.

H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall include panel designation, voltage and phase in minimum ¼” high letters.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values.

3.4 FIELD QUALITY CONTROL

A. Testing: Refer to Section 260501 – Field Test and Operational Check.

B. After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements

   1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balancing Loads: After Substantial Completion, measure load balancing and make circuit changes as follows:

   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.
B. Adjust all operating mechanisms for free mechanical movement.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416
SECTION 262418 – MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes ac general-purpose starters rated 600 V and less.

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

B. Shop Drawings: For each enclosed starter.
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. UL listing for series rating of overcurrent protective devices in combination starters.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination starters.


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

D. Maintenance Data: For enclosed starters and components, include the following:
   1. Routine maintenance requirements for enclosed starters and all installed components.
   2. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.

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

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

B. Source Limitations: Obtain enclosed starters of a single type through one source from a single manufacturer.

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

D. Comply with the NEC.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed starters indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed starters from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed starters with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed starters and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed starter with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7 EXTRA MATERIALS

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

1. Spare Fuses: Furnish one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Manual and Magnetic Enclosed Starters:
   b. General Electric Co.
2.2 MANUAL ENCLOSED STARTERS

A. Description: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.

2.3 MAGNETIC ENCLOSED STARTERS

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

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

C. Combination Starter: Factory-assembled combination starter and disconnect switch.
   1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
   5. A minimum wiring space of 2” clear on both sides and 4” clear top and bottom. Open and accessible through the door.

2.5 ACCESSORIES

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


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

D. Control Relays: Auxiliary and adjustable time-delay relays.
E. All starters shall include a terminal strip for all control connections and be accessible through front door.

F. All starters to be furnished with 4 sets of normally open / normally closed auxiliary contacts.

2.6 FACTORY FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive enclosed starters for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

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

B. Select horsepower rating of starters to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For starters not at walls, provide freestanding uni-strut racks.

B. Enclosed Starter Fuses: Install fuses in each fusible switch.

3.4 IDENTIFICATION

A. Provide engraved laminoid nameplate for each starter indicating equipment served.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed starters according to Section 260519 - Conductors and Cables.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed starter circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS
A. Conduit installation requirements are specified in other Sections 260533 – Raceways and Boxes. Drawings indicate general arrangement of conduit, fittings, and specialties.
B. Ground equipment.
C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.7 FIELD QUALITY CONTROL
A. Verify that enclosed starters are installed and connected according to the contract documents.
B. Verify that electrical wiring installation complies with manufacturer’s submittal and installation requirements.
C. Complete installation and startup checks according to manufacturer’s written instructions.

3.8 ADJUSTING
A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 CLEANING
A. Clean enclosed starters internally, on completion of installation, according to manufacturer’s written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262418
SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes receptacles, switches, and finish plates.

1.3 DEFINITIONS
   A. GFCI: Ground-fault circuit interrupter.
   B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS
   A. Submit shop drawings and product data.

1.5 COORDINATION
   A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers:
      1. Wiring Devices:
         a. Bryant; Hubbell, Inc.
         b. GE Company; GE Wiring Devices.
         c. Hubbell Wiring Device – Kellems
         d. Leviton Manufacturing Co., Inc.
         e. Pass & Seymour/Legrand; Wiring Devices Div.
         f. Cooper Wiring Devices
         g. Or approved equal.
      2. Wiring Devices for Hazardous (Classified) Locations:
2.2 RECEPTACLES

A. Straight-Blade and Locking Receptacles: Specification grade (construction specification grade prohibited), white color.

B. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter. White color

C. Isolated-Ground Receptacles: Equipment grounding contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from mounting strap, orange plastic face, specification grade.
   1. Devices: Listed and labeled as isolated-ground receptacles.
   2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

D. TVSS Receptacles: Duplex type, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground, blue plastic face.

E. Multi-Outlet assemblies: Metal with White color finish.

2.3 SWITCHES

A. Snap Switches: General-duty, quiet type, rated 20 amperes, 120/277 volts AC. Handle: white plastic. Pilot light type (where indicated): lighted handle.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters.
   2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.
   3. Fluorescent Lamp Dimmers: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming to a maximum of 1 percent of full brightness.

2.4 WALL PLATES

A. Single and combination types match corresponding wiring devices.
   1. Cover plate: Stainless Steel.
   2. Cover plate for surface mounted devices: Galvanized steel.
   3. Weatherproof cover plate: While in use, gasketed, cast metal, hinged device covers.
4. Plate-Securing Screws: Metal with head color to match plate finish.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install devices and assemblies plumb and secure.
   B. Install wall plates when painting is complete.
   C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
   D. Do not share neutral conductor on load side of dimmers.
   E. Arrangement of Devices: Unless otherwise indicated, mount flush, vertically, with height as indicated or six inches above counters.
   F. Group adjacent switches under single, multigang wall plates.
   G. Protect devices and assemblies during painting.
   H. Install wall switches with off position down.
   I. Install cover plates on switch, receptacle, and blank outlets.

3.2 IDENTIFICATION
   A. Switches and receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on the outside of the face plate for receptacles and on the inside of the face plate for switches; utilize durable wire markers or tags within all outlet boxes. Labels shall be Brother ½" TZ tape, black ink on clear, extra-strength adhesive tape, with size 18 text or engineer approved equal. Use matching label printer.

3.2 CONNECTIONS
   A. Connect wiring device grounding terminal to outlet box with bonding jumper.
   B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
   C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.
   D. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values.

3.4 FIELD QUALITY CONTROL
   A. Test wiring devices for proper polarity and ground continuity. Check each device to verify operation.
B. Test GFCI operation according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726
SECTION 262815 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED
   A. Provide and install motor disconnects.
   B. Provide and install circuit disconnects.

1.3 REFERENCES
   A. Underwriters' Laboratory, Inc. - Annual Product Directories.
   B. NEMA - Classification of Standard Types of Nonventilated Enclosures for Electric Controllers.

1.4 REGULATORY REQUIREMENTS
   A. Conform to National Electrical Code and to applicable inspection authority.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Cutler-Hammer/Westinghouse, General Electric, Siemens, Square D, or approved equal.

2.2 COMPONENTS
   A. Motor and circuit disconnects shall have an Underwriters' Laboratory label.
   B. Single Phase 120 Volt Disconnect Switches: Single pole toggle switch with thermal overload motor protection where indicated. A Horse Power rated switch may be used where fractional horse power motors have internal overload protection.
   C. Single or Three Phase Motor Disconnect Switches: two or three pole heavy duty or fusible where other loads are on same circuit, 250 or 600 volt as required in NEMA Type 1, 3R, or 4 enclosures designed to reject all except Class 'R' fuses.
2.3 **ACCEPTABLE MANUFACTURERS - FUSES**

A. Cooper Bussmann, Edison, Littelfuse, Ferraz Shawmut, or approved equal.

2.4 **FUSES**

A. As indicated on the drawings. All shall be of the same manufacturer. Provide one spare set of fuses (minimum of three) for each current rating and type used.

**PART 3 - EXECUTION**

3.1 **INSTALLATION**

A. Install motor and circuit disconnect as indicated on Drawings and as required by Code. Where fuses are indicated, provide fuses correlated with full load current of motors provided.

END OF SECTION 262815
SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces and recessed in canopies, lamps, ballasts, emergency lighting units, and accessories.

B. Related Sections include the following:
   1. Section 260923 Lighting Control Devices.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features and accessories.

B. Maintenance data for lighting fixtures.

C. Emergency lighting units including battery and charger.

1.4 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with the NEC.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 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, partition assemblies, and other construction.
1.6 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 Lighting Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: As indicated on the drawings.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. 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.

D. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

2. Lens Thickness: 0.125 inch minimum, unless greater thickness is indicated.

2.5 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Remote Test – Where indicated on the drawings: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7. Integral Self-Test – Where indicated on the drawings: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.8 FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

F. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

2.9 FINISHES

A. Fixtures: Manufacturer’s standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.


PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Furnish and install a protective barrier around fixtures that are not insulation-contact-rated (non-IC-rated) in locations where insulation is installed. The protective barrier shall be installed to yield a 4” air-gap from the fixture on all sides and top.
C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Attach supports to building structure.
   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
   2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
   3. Fixtures of Sizes Less Than Ceiling Grid: Arrange 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.

D. Suspended Fixture Support: As follows:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   3. Continuous Rows: Suspend from cable installed according to fixture manufacturer’s written instructions and details on Drawings.

3.2 CONNECTIONS

A. Ground equipment.
   1. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests: As follows:
   1. Verify normal operation of each fixture after installation.
   2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 265100
SECTION 266000 – ELECTRICAL DEMOLITION AND REPAIR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes electrical demolition and repair. Work includes removal of obsolete wiring and electrical apparatus; relocation, reconnection or replacement of existing wiring affected by demolition or new construction; capping off concealed wiring abandoned due to demolition or new construction.

PART 2 - PRODUCTS

2.1 EQUIPMENT
A. Conductors and Cables: Refer to Section 260519 – Conductors and Cables.
B. Raceways and Boxes: Refer to Section 260533 – Raceways and Boxes.

PART 3 - EXECUTION

3.1 DEMOLITION
A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety. Completely remove all exposed traces, hardware, wiring and conduit systems to the source. All knockouts and holes shall be patched or plugged.

C. Contractor shall re-use existing straight conduit runs and factory bends for conduits 2” and larger, provided that they are not damaged in any way and are installed in accordance with Section 260533.

D. Re-use of all other electrical apparatus and material is subject to approval by owner.

E. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

F. Remove demolished material for recycling as directed by owner.
G. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

H. Power outages shall be held to a minimum and coordinated with the owner. Contractor shall schedule outages during off-hours.

END OF SECTION 266000
SECTION 271101 – TELECOM RACEWAY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes telecom raceway systems.

1.3 RELATED WORK
A. Section 260533 – Raceways and Boxes.
B. Section 260536 – Cable Trays.

1.4 SYSTEM DESCRIPTION
A. Conduit, cable trays and boxes to form an empty raceway system.

PART 2 - PRODUCTS

2.1 EQUIPMENT
A. Conduit: Refer to Section 260533.
B. Cable trays: Refer to Section 260536.
C. Outlet, pull or junction boxes: Refer to Section 260533.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Provide pullboxes in telecom conduit runs spaced less than 100 feet apart, and on the backboard side of runs with more than two right angle bends.
B. Place telecom label on pull and junction boxes.
C. Provide pullwire in each telecom conduit run.
SECTION 27130 - COMMUNICATIONS CABLING

PART I - 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 SCOPE OF WORK

A. The Contractor shall furnish and install all materials for a complete, functional data and voice communications system in accordance with this specification and the contract drawing. Contractor shall be responsible for providing a complete, functional system including all necessary components, whether included in this specification or not.

B. The installation shall include all cable and raceway (twisted-pair copper, fiber optical cabling, and coax cabling), conduit raceway, innerduct, interconnect-patching equipment, connectors, and jumpers, wiring blocks and telecommunications outlets. There will be two types of installation – 1) UTP installed in surface mount raceway (approved only in unfinished areas), and 2) UTP installed in conduit and boxes within walls or above ceilings. Multiple drops in a single box within wall will be fed by one vertical raceway with raceway sized to accommodate the required cabling – see building drawings for additional information.

C. In addition to material and equipment, Contractor shall provide labor and any incidental material required for installation. All copper station cables shall be terminated on patch panels at distribution frames and on data communication outlets at the workstation end, all fiber optical cables shall be terminated on rack mounted light interface units (LIU), all coax cables to be terminated on amplifiers in rack and on f connectors at the outlet end.

D. The owner and user, upon completion of the project, shall furnish all active equipment unless specifically noted on drawings and within specifications.

E. Upon completion of installation, Contractor shall test all copper, fiber optical, and coax cabling and record the test results in a test results binder and deliver to owner.

F. The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context “good quality” means the work shall meet industry technical standards and quality of appearance. The owner reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

G. Voice and data cabling and outlets for pay phones, fax machines, modems, wall telephones, and fire alarm communicators, including Fire Alarm Communicator testing, shall be provided by Contractor.

H. All cable trays, wiring and server racks, etc., shall be furnished and installed by the contractor when indicated on the drawings and/or in this specification.

I. Cable shall be routed as close as possible to the ceiling, floor, or corners to insure that adequate backboard space is available for current and future equipment and for cable terminations.
not be tie-wrapped to electrical conduit, ceiling grid wire or other equipment. Minimum bend radius shall be observed. Cable transitions between plenum and non-plenum spaces, through drop ceilings (between horizontal and vertical risers), and through walls shall be routed through appropriate sized cable sleeves.

1.3 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. 9/125-micrometer, optical fiber cabling.
5. Cable connecting hardware, patch panels, and cross-connects.

B. Related Sections:

1. Drawing and General Provisions of the Contract, apply to work specified in this Section.
2. Applicable Standards: All work shall be performed in accordance with the latest revisions of the following standards.
   - ANSI/TIA/EIA-568-C.1 and addenda "Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements"
   - ANSI/TIA/EIA-568-C.2 and addenda "Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair Cabling Components"
   - ANSI/TIA/EIA-569-A and addenda "Commercial Building Standard for Telecommunications Pathways and Spaces"
   - ANSI/TIA/EIA-606-A and addenda "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings"
   - ANSI/TIA/EIA-607 and addenda "Commercial Building Grounding and Bonding Requirements for Telecommunications"
   - ANSI/TIA/EIA-526-7 "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant"
   - ANSI/TIA/EIA-526-14-A
   - International Fire Code 2003 Edition

The most recent versions of all documents apply to this project.

B. Quality Assurance
1. Contractor Qualifications: Work in this section shall be performed by a licensed and bonded low voltage contractor, which has been in business for a minimum of five years in the maintenance and installation of high-speed data and voice networks. Only Contractors whose primary business in that of installing, maintaining, troubleshooting and testing computer and communication network systems shall perform this work.

2. The Contractor shall have installed cable plant in at least three buildings similar in size and scope to the project building and shall furnish references to the Owner and/or Engineer upon request.

3. The Contractor shall be completely familiar with the TIA/EIA standards for telecommunications raceway / pathway infrastructure systems and with the telecommunications design practices as defined in the BICSI Telecommunications Distribution Methods Manual.

4. Contractor must be a trained and certified for the communications cable and hardware, which it installs, and must furnish proof of certification.

5. Contractor should have a BICSI registered RCDD on staff.

6. A Systimax Solutions System Warranty shall provide a complete 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 25 years. The manufacturer of the telecommunications equipment, devices and cable shall warrant the entire telecommunications structured cable system to be in compliance with applicable codes and standards, and to be free from defects in materials and workmanship. The warranty shall apply to all passive structured cabling system components, and shall cover failure of the system to support applications in accordance with the performance levels stipulated in the referenced TIA/EIA standards. This warranty shall extend for a period of at least (25) years from the date of final field-testing and acceptance of the system, and shall cover the full cost of all repairs and all replacement for the entire system.

7. Upon successful completion of the installation and subsequent inspection by the manufacturer’s project manager, the certified SYSTIMAX contractor of the telecommunications equipment, devices and cable shall register the telecommunications structured cable system installation, and shall furnish a numbered registration certificate to the owner immediately upon completion. Both copper and fiber test results should be submitted in the test manufacturers native format to CommScope for review with the submitted Warranty Application. A soft copy of the test results will also be sent to West Ada School District for their record.

8. A factory registered Systimax Solutions System contractor shall be on the construction site at all times while work is being performed; no subcontracting shall be allowed. All products specified herein shall be installed by the contractor represented in the proposal. The contractor shall have completed standards based product and installation training. A copy of the Systimax Solutions System Contractor Registration shall be submitted in the proposal.

   a. All Systimax Solutions System non-consumable products have a 25-year guarantee. When installed per TIA or ISO/IEC standards, the Systimax Solutions System Network Cabling System will operate the application(s) for which the system was designed to support. Applications may include, but are not limited to:

       10/100/1000/10000 Mbps Ethernet (IEEE 802.3)
       4/16 Mbps Token Ring (IEEE 802.5) 155, 622,
       1.25 Gbps ATM
In order to qualify for the guarantee, the structured cabling system must be installed per the following:

1. Meet all TIA/EIA commercial building wiring standards.
2. Systimax Solutions System categorized product must be used in conjunction with an equivalent or higher Category UL or ETL verified cable.
3. Systimax Solutions System must be installed per Systimax Solutions System instruction sheets.

Note: All Networks shall be installed per applicable standards and manufacturer's guidelines.

If any Systimax Solutions System product fails to perform as stated above, Systimax Solutions System will provide new components at no charge.

9. LICENSE CLASSIFICATION: Contractor must possess a valid Idaho State Contractor’s License.

1.4 DEFINITIONS


B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.5 BACKBONE CABLEING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross connection.
B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.6 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

B. Governing Codes and Conflicts

1. If the requirements of this section or the Project Drawings exceed those of the governing codes and regulations, then the requirements of this section and the Drawing shall govern. However, nothing in this section or the Drawings shall be construed to permit work not conforming to all governing codes and regulations.

1.7 SUBMITTALS

A. Prior to installation of any equipment, the Contractor shall provide the Engineer and/or the Owner with six (6) copies of submittals and drawings for approval. Submittals shall include a list of equipment with model numbers and quantities, catalog cuts, equipment specification sheets and installation instructions. Drawings shall include floor plans with equipment and wire locations, room numbers, one-line risers, and the jack numbering system proposed for the project. No equipment shall be purchased for the project until shop drawings have been reviewed and approved by the engineer and/or the owner.

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

1. For UTP (Copper) cable, include the following installation data for each type used:
   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

2. For Fiber Optical cable, include the following installation data for each type used:
   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

3. For coaxial cable, include the following installation data for each type used:
   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

4. For all components of the system.

C. Shop Drawings:
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:
   b. Patch panels.
   c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

D. Substitution Requests

1. Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Use CSI Form 13.1A or contractor/vendor form, which is substantially similar to the CSI form.
2. Show compliance with requirements for substitutions and the following, as applicable:
   a. Statement indicating why specified material or product cannot be provided.
   b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   d. Product Data, including drawings and descriptions of products and fabrications and installation procedures. Provide all available engineering documents, instructions, drawings and third party test reports.
   e. Samples of each of the products being offered for substitution.
   f. List of similar installations for completed projects with project names and addresses and names and address of architects and owners.
   g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
   h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
   i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified in the Work, including effect on the overall...
Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer’s letterhead, stating lack of availability or delays in delivery.

j. Cost information, including a proposal of change, if any, in the Contract Sum.
k. Contractor’s certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
l. Contractor’s waiver of rights to additional payment or time that may subsequently become necessary because of failure or proposed substitution to product indicated results.
m. Acceptance of substitution must be received from the Owner in writing.

E. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

F. Source quality-control reports.

G. Field quality-control reports.

H. Maintenance Data: For splices and connectors to include in maintenance manuals.

I. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under the direct supervision of Registered Systimax Solutions System Technician, who shall be present at all times when Work of this Section is performed at Project site.
   2. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.
   1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.9 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. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: 5% of total of each type.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner’s telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All products shall be new, and brought to the job site in original manufacturer’s packaging.

1. Electrical components shall bear the Underwriter’s Laboratories label.
2. Comply with TIA/EIA-569-A.

B. Telecommunications System Description

1. Provide the indicated number of Category 6A cables to each outlet. All horizontal cables are terminated on Category 6A UTP jacks installed in rack-mounted modular patch panels. Horizontal data circuits are connected to LAN electronics within each data rack location.

C. Cable Support: NRTL labeled for support of Category 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools and J-hooks.
3. Straps and other devices. D. Cable Trays:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. WBT
      b. Cooper B Line
   2. See specification section 260536 CABLE TRAYS FOR ELECTRICAL SYSTEMS for further information.

   E. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
      1. Outlet boxes shall be no smaller than 4 inches wide, 3 inches high, and 4 inches deep.
      2. Conduit shall be no smaller than 1."

2.2 HORIZONTAL DISTRIBUTION SUB-SYSTEM

A. Work Area Faceplate
   1. Number of jacks per outlet location is as shown on plans. Use single-gang, flush mounted faceplates. Faceplates, single and double gang boxes shall match receptacle and switch cover plates per spec section 26 “wiring devices”. Provide blank faceplate inserts at any unfilled parts at the faceplates.

      Approved Manufacturer:
      CommScope: M12L-262 (MID: 108168469) 2 PORT WHITE

B. 4pr UTP Cabling
   1. Horizontal station cable shall be Category 6A, 23 AWG UTP, UL/NEC CMR or CMP, non-plenum or plenum rated with a PVC jacket as required for the application. Any Horizontal Cabling being installed above drop ceiling shall be Plenum rated unless written permission by West Ada School District to install non-Plenum. In order to run non Plenum cable the vendor must provide verification that the area being run is non Plenum rated and get written permission from the director of I.T and head of facilities.

      2. Cable color designation should use to identify the systems application. The following colors will be used:
         Blue = Data Network
         Green = WAP
         Orange = Security Camera and Locks
         Yellow = Speakers and Clocks

      Approved manufacturer:
      SYSTIMAX: PVC 1091B
      SYSTIMAX: Plenum 2091B

C. Modular Jacks
   1. All modular jacks shall be wired to the T568B wiring pattern. Modular jacks shall be of Snap into type. Modular jacks shall be UL Listed.
2. Category 6A modular jack devices, 8-position, 8-conductor modular jacks shall terminate unshielded twisted four pair, 22-26AWG, 100 Ohm cable and shall not require the use of a punch down tool. Jack module shall use forward motion termination to optimize performance by maintaining cable pair geometry and eliminating conductor untwist.

3. Information Outlet color designation should use to identify outlet application. The following colors will be used:
   - Blue = Data Network
   - Green = WAP
   - Orange = Security Camera and Locks
   - Yellow = Speakers and Clocks

4. Refer to drawings and electrical legend for symbol type and/or notes, which dictates the number of jacks and cable drops required.

   Approved manufacturer:
   SYSTIMAX: MGS600–318  (MID: 760092452)  CAT6A BLUE
              MGS600–226  (MID: 760092403)  CAT6A GREEN
              MGS600–112  (MID: 760092379)  CAT6A ORANGE
              MGS600–123  (MID: 760092387)  CAT6A YELLOW

D. Raceway

1. Work shall include furnishing all raceway and appropriate fittings and device plates to install a nonmetallic surface raceway system as indicated in the project drawings. Installer shall comply with detailed manufacturer’s instruction sheets which accompany system components.

2. All surface mounted raceways will be affixed to walls with the appropriate screws via prepunched mounting holes. No adhesive tape shall be used to secure the raceway

3. Multiple drops on a single wall will be fed by one vertical raceway.

4. All raceway will be plum and level.

5. Refer to drawing for locations and mounting heights and arrangement.

   Approved manufacturer: Panduit or Wiremold

2.3 HORIZONTAL CROSS-CONNECT TERMINATION HARDWARE

A. Horizontal Data Cross-Connect

1. Copper Patch Panels will be mounted in rack in specific order based on systems application. From Top Down the Panel will be Data Network, WAP, Informacast & Security. See drawings below. Patch Panels will be dedicated for their application.
2. Patch panels shall be SYSTIMAX 360 1100 series 24 port, imVision Enabled, flat panel.

   Approved Manufacturer:
   SYSTIMAX: 360-IP-1100-E-GS6-1U-24  (MID: 760201145)

3. Horizontal data cross-connect patch cords shall be provided for 100% of the patch panel Terminations and be of adequate length to ensure proper cable bending radius and terminations can be achieved.

   Approved manufacturer:
   SYSTIMAX:
   A. Provide 1 foot blue patch cord for all Data Network.
      Part #: CPCSSX2-0ZF001
   B. Provide 1 foot green patch cord for all WAP terminations.
      Part #: CPCSSX2-04F001
   C. Provide 1 foot orange patch cord for all camera and keypad terminations.
      Part #: CPCSSX2-06F001
   D. Provide 1 foot yellow patch cord for all Informacast speakers.
      Part #: CPCSSX2-09F001
   E. Provide 1 foot red patch cord for all management devices such as climate control.
      Part# CPCSSX2-07F001
   F. Provide 1 foot white patch cord for analog devices such as fax machines.
      Part# CPCSSX2-08F001

2.4 CABLE MANAGEMENT TIES

   A. Bundle all communications cables together with Hook & Loop-type tie wraps. Cables of similar type should be bundled together. ie; Cat6 in a bundle, Cat5e in a separate bundle & Coax in a separate bundle.

   Approved Manufacturer: Panduit or Leviton hook and loop cable ties

2.5 COMMUNICATIONS BACKBOARD

   A. Data/Voice terminal backboards shall be ¾” thick plywood painted with two (2) coats of White, fire retardant paint, APA exterior grade Douglas Fir A-C, and fire retardant with flame spread rating not more than 25 when tested according to ASTM E-84. Refer to drawing for locations, quantities and mounting arrangement.

2.6 EQUIPMENT MOUNTING RACKS

   A. Equipment Rack(s): Contractor will use owners existing enclosed and open racks when possible. Provide 19” wide with number of vertical rack sections as required to allow space for termination of all Category 6 cabling plus mounting space for multi-port switches required to cross-connect all data jacks. See Drawings for details. Rack location to be determined by owner. Owner desires a 4 post rack in each data closet with a minimum of a 4 post in the MDF. If 4 post racks don’t fit in the IDF then a 2 post rack should be installed. If a 2 post rack will not fit then please contact Meridian School District prior to
moving to wall mounted racks. Note (3 foot area in front and behind the rack should be left open for accessibility) Where possible all power requirements should be put on the rack to prevent tripping hazards behind or in front of the rack.

1. Approved Manufacturer for Enclosed Wall Mount Cabinet: CommScope  MID: 760 095 992
2. Fan Kit for Wall Mount Cabinet: MID: 760096081
3. Filter Kit for Wall Mount Cabinet: MID: 760096149
5. CommScope Two Post Rack: MID: 760082479

B. Distribution Rack Grounding: furnish ground terminal strip for each rack section installed. Rack shall be grounded using stranded, #6 AWG Green insulated copper conductor. Furnish all required bonding material and hardware, and bond to building grounding electrode subsystem

1. Approved Manufacturer: Chatsworth

C. Cable Runway: Cable trays shall be installed in hallway above the suspended ceilings supported at a maximum of four-foot intervals. Cable tray path will be determined by owner and contractor and tray size determined by number of cables.

1. Approved Manufacturer: WBT  P/N WBTS4X18

Equip each floor rack with ladder style cable runway installed between the backboard and the equipment rack. Securely attach to backboard and rack in accordance with manufacturers written instructions. See Drawings for details.

1. Approved Manufacturer: Commscope  P/N: 760085647

D. Vertical Wire Management: The Cable Management System shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures. The system shall protect network investment by maintaining system performance, controlling cable bend radius and providing cable strain relief.

The Vertical Wire Management used at Meridian School District projects shall be either Single Sided or Double Sided per the project design. Each floor mounted rack shall have a Vertical Wire Manager on each side of rack for routing of cable on the back side and patch cords on the front side. If two racks are side by side, then only one Vertical Wire Manager is needed in-between with another Vertical Wire Manager on each end of row.

No Vertical Wire Manager is required for Wall Mounted racks/cabinets.

Approved Manufacturer
1. Single sided: CommScope VCM-SS-84-6 (MID: 760072868)
2. Double Sided: CommScope VCM-DS-84-6 (MID: 760072785)

2.7 OPTICAL FIBER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. SYSTIMAX Solutions; TeraSPEED

B. Interior Optical Fiber Description: Singlemode, OS2, 12-fiber, distribution Plenum, Armored, gel-free optical fiber cable. CommScope number P-012-DZ-8W-FSUYL

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. General Purpose, Nonconductive: Type OFN or OFNG.
   2. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   3. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.

5. Conductive cable shall be aluminum armored type.
7. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

C. Singlemode fiber optic Premises Cable – Zero Water Peak – Riser and Plenum

1. The cable shall be available in riser and plenum types with a Yellow sheath.
2. The premises cable shall use a standard colored tight buffered construction.
3. The higher fiber count cables shall utilize a sub-unitized design with color-coded sub units for easy identification.
4. The cable shall deliver a cost-effective upgrade path by expanding the available wavelengths by 50% and allowing up to 18 channels of CWDM (Coarse Wave Division Multiplexing) on a single fiber and up to 400 channels of DWDM (Dense Wave Division Multiplexing) on a single cable.
5. The cable shall operate over the entire wavelength range from 1260 nm to 1625 nm, removing the water peak (high attenuation) in the E-band, adding more than 50% in operational wavelength range over conventional singlemode fiber.

Physical Specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Diameter:</td>
<td>8.3 µm nominal</td>
</tr>
<tr>
<td>Cladding Diameter:</td>
<td>125.0 (± 0.7) µm</td>
</tr>
<tr>
<td>Core/Clad Offset:</td>
<td>&lt; 0.5 µm</td>
</tr>
<tr>
<td>Cladding Non-Circularity:</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Coated Fiber Diameter:</td>
<td>245 (± 10) µm</td>
</tr>
<tr>
<td>Cladding/Coating Offset:</td>
<td>&lt; 12 µm</td>
</tr>
<tr>
<td>Colored Fiber Diameter:</td>
<td>254 (± 7) µm</td>
</tr>
<tr>
<td>Proof Test:</td>
<td>0.7 GPa</td>
</tr>
<tr>
<td>Fiber Curl:</td>
<td>&gt; 4 m</td>
</tr>
<tr>
<td>Dynamic Fatigue Parameter:</td>
<td>&gt; 18</td>
</tr>
</tbody>
</table>
**Macrobend (100 turns, 50 mm mandrel):**

- 0.10 dB @ 1310 nm and 1550 nm

**Macrobend (1 turn on a 32 mm mandrel):**

- 0.50 dB @ 1310 nm and 1550 nm

---

### Optical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode Field Diameter</td>
<td>9.2 (± 0.3) µm @ 1310 nm, 10.4 (nominal) @ 1550 nm</td>
</tr>
<tr>
<td>Group Index of Refraction</td>
<td>1.466 @ 1310 nm and 1.383 (± 3) @ 1550 nm</td>
</tr>
<tr>
<td>Attenuation of Tight Buffered Fibers:</td>
<td>0.7 dB/km @ 1310 nm</td>
</tr>
<tr>
<td>Maximum Dispersion:</td>
<td>3.5 ps/nm-km @ 1285 to 1330 nm, 18 ps/nm-km @ 1550 nm</td>
</tr>
<tr>
<td>Zero-Dispersion Wavelength:</td>
<td>1300 - 1322 nm</td>
</tr>
<tr>
<td>Zero-Dispersion Slope:</td>
<td>0.092 ps/(nm)²/km</td>
</tr>
<tr>
<td>Polarization Mode Dispersion LDV:</td>
<td>0.08 ps/(km)⁷⁵</td>
</tr>
</tbody>
</table>

---

D. Exterior Optical Fiber Description: Single mode, 9/125 micrometer, 12-fiber, Indoor/Outdoor, distribution Riser, non armored, gel-free optical fiber cable. CommScope number R-012-LN-8W-F12BK/25D

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
4. Maximum Attenuation: 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
5. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

E. Jacket:

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

---

### 2.8 OPTICAL FIBER CABLE HARDWARE

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

   1. Systimax SCS.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: 12 for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.

Approved Manufacturer for 9/125 SM
1. CommScope: 1 Meter Duplex LC Yellow; Part #: FEWLCLC42-JXM001
2. CommScope: 2 Meter Duplex LC Yellow; Part #: FEWLCLC42-JXM002
3. CommScope: 3 Meter Duplex LC Yellow; Part #: FEWLCLC42-JXM003

D. Fiber Optic Connectors: SYSTIMAX QWIK II Fiber Optic Connectors shall be pre-polished, cam termination, simplex fiber optic connectors for multimode glass fiber that fully complies with both the fiber optic connector performance requirements specified in TIA/EIA-568-B.3 and the intermateability requirements specified by the TIA-604 FOCIS-3 standard.

Approved Manufacturer
1. 9/125 SM: SYSTIMAX SFC-LCF-09-8X (MID: 760117895)

E. Rack Mounted Fiber Optic Patch Panels: Provide rack mounted modular enclosure units complete with connector couplings mounted in LC connector panels for interconnection of backbone optical fiber cables as specified herein. Units shall be sized to terminate all fibers indicated on the Drawings using mechanical or fusion splices.

Approved Manufacturer
1. SYSTIMAX 360G2-1U-MOD-SD (MID: 760193771)
2. 9/125 SM: 360G2-Cartridge-12-LC-SM-BL (MID: 760109272)

2.9 COAXIAL CABLE

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

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz. C. RG6/U: NFPA 70, Type CATVR.

1. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
4. Color-coded PVC jacket.

C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

2.10 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Leviton Voice & Data Division.
   2. Siemon Co. (The).

B. Coaxial-Cable Connectors: Type F Connector

C. Coax amplifiers mounted in each rack: Blondertongue model HAD-16-860-16
   1. Each IDF room to have Coax cable amplifier with radial feeds to each classroom TV and incoming
   feed from MDF.

2.11 UTP CABLE

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

B. Description: 100-ohm, four-pair UTP, binder groups covered with a blue thermoplastic jacket.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL
      444 and NFPA 70 for the following types:
      a. Communications, General Purpose: Type CM or CMG.
      b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
      c. Communications, Riser Rated: Type CMR, complying with UL 1666.
      d. Communications, Limited Purpose: Type CMX
      e. Multipurpose: Type MP or MPG
      f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
      g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.12 UTP CABLE HARDWARE

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

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with
   modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware
   of same category or higher.
C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
   1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   1. Number of Jacks per Field: One for each four-pair UTP cable indicated plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in 1 Foot length for patch panel end and 10 Foot for outlet end lengths; terminated with eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6a performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.
   3. Provide an additional 25% more than the total terminations at patch panels.

2.13 LOW-VOLTAGE CONTROL CABLE
A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with NFPA 262.

2.14 CONTROL-CIRCUIT CONDUCTORS
A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.
B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.
C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.15 GROUNDING
A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors. B. Comply with ANSI-J-STD-607-A.
2.16 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.17 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-C.3.

C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 PRODUCTION INSPECTIONS

A. The Contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of proper gauge, containing correct number of pairs, and is the material ordered. Any physical damage to the cable and wire must be noted: nonuniform jacket thickness and jacket tightness should also be identified. Note any buckling of the jacket, which would indicate possible problems.

B. Installation approval by owner is required at each phase of construction as noted below. Proceeding without owner approval may result in rejection of work and/or installation and result in the contractor removing newly installed raceway, boxes, cables, racks, and etc (all system components).
1. Submittal documents (shop drawings).
2. Substitution requests.
3. Raceway Rough-in.
4. Rack location and installation.
5. Grounding.
6. Patch panel installation.
7. Contractor furnished electronics equipment.
8. Cable installation.
9. Cable terminations at Rack and faceplate.
10. Installation of faceplates.

3.2 INSTALLATION OF CABLES

A. Comply with NECA
B. General Requirements for Cabling:

2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices." Install 110-style IDC termination hardware unless otherwise indicated.
3. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer’s limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
10. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.
11. Conduit and Raceway Usage: All communications cable shall be installed in grounded metal conduit or raceway dedicated for communications purposes, when called for on the Project Drawings, and not to be shared with electrical wiring. Cable trays shall be installed in hallway above the suspended ceilings supported at a maximum of four-foot intervals. Cable tray path will be determined by owner and contractor and tray size as noted in specifications and on drawings.
12. Cable Lubricants: Lubrications specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit. After installation, exposed cable and other surfaces must be cleaned of lubricant residue. Recommended Products: Dyna-Blue, American Polywater.
13. Conduit and Raceway Fill: In general, communication raceway shall not be filled beyond 40% capacity.
14. Backboard and Rack Cable Supports: Clamps, “D-Rings” and Velcro tie-wraps are all Acceptable ways to support cable. However, installation of these supports must be done with care so as not to cause crushing or distortion of the cable, nor cause tighter bends than the minimum radius permitted for each type cable. Refer to “Part 2-Products” of this specification section for specified supports and tie-wraps. C. UTP Cable Installation:

2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:
   1. Comply with TIA/EIA-568-B.3. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Outdoor Coaxial Cable Installation:
   1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
   2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 DATA/TELEPHONE STATION CABLING

A. Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. No more than 12” of slack shall be stored in an in-wall box. Excess slack may be neatly coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable. Each cable shall be labeled with a numbering scheme approved by the Owner, at each end of the cable.

B. In addition, each cable type shall be terminated as indicated below:

1. Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-A document, manufacturer’s recommendations and/or best industry practices.

2. Pair untwist at the termination shall not exceed one-half an inch for Category 6 connecting hardware.

3. Bend radius of the cable in the termination area shall not be less than 10 times the outside diameter of the cable.

4. The cable jacket shall be maintained as close as possible to the termination point.

5. Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s). Modem jacks shall be considered the last voice jack in the sequence.

C. Station drop cable terminations shall be made at the data port at the patch panel and the same data outlet at the data/telephone station location. Label patch panel port and station outlet the same. At each outlet box, a sufficient length of spare cable will be provided for terminating outlet devices such that the outlet can be easily removed and inspected.

D. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of four-foot intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

E. Horizontal distribution cables shall be bundled in groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.

F. Cables shall not be attached to ceiling grid or lighting support wires. Where light support for drop cable legs is required, the contractor shall install clips to support the cabling.

G. The installation of cables around movable devices, instruments, sub panels, etc., shall be provided with adequate support, length, protection, and flexibility so that the cable is not damaged in the event the equipment is moved.

H. Data cable may be run perpendicular, parallel or at 45 degrees to building grid lines (excluding radial and circulate grid lines). Cable in ceilings and below raised floor areas shall be grouped.
and wrapped in Velcro bundles of two or more cables as appropriate. Every attempt shall be made to avoid running telecommunications close to (less than 24") and parallel to power raceway and wiring, or close to light fixtures.

3.4 MDF/IDF BACKBOARD CABLING

A. Cable installation must conform to the Project Drawings. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purposes such as access boxes, ventilation mixing boxes, access hatches to air filters, switch or electrical outlets, electrical panels, fire alarm equipment, clock systems, and lighting fixtures. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser without difficulty at a later time by maintaining maximum distance from these openings.

B. Cable shall be routed as close as possible to the ceiling, floor, or corners to insure that adequate backboard space is available for current and future equipment and for cable terminations. Cables shall not be tie-wrapped to existing electrical conduit or other equipment. Minimum bend radius shall be observed.

C. Lay cables via the shortest route directly to the nearest edge of the backboard from the mounted equipment or block. Lace or tie-clamp all similarly routed cables together, and attached by means of clamps screwed to the outside edge(s) of the backboard vertically and/or horizontally, then route via “square” corners over a path that will offer minimum obstruction to future installations of equipment, backboards, or other cables.

3.5 BACKBONE CABLE

A. Backbone cables shall be installed separately from horizontal distribution cables.

B. Where backbone cables and distribution cables are installed in a cable tray, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

3.6 CABLE LABELING

A. All cables shall be labeled at each end with the same numbering scheme as approved by West Ada School District

B. The Contractor shall follow the West Ada School District approved labeling scheme for both faceplate and patch panel location (shown below). All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. Patch Panels shall be labeled A, B, C….Z continuous without skipping letters for each rack. The Panels shall be labeled on both front and back of Panel. See Labeling example below.
C. All label printing will be machine generated label using black on clear adhesive Mylar tape. Self laminating labels will be used on cable jackets, appropriately sized to the outside diameter of the cable, and placed within view at the termination point on each end. Outlet labels will be the manufacturer’s labels provided with the outlet assembly. The specific nomenclature for labels shall follow West Ada School District labeling Scheme.

D. Station Faceplate and Patch Panel Labeling. Each station outlet terminal shall be identified and marked on the patch panel as described below:

E. All devices that are connected to the network but use a biscuit instead of a wall jack that prevents the user from seeing the jack information without having to unmount the device such as wireless access points, clocks, speakers, and cameras need to be labeled clearly on the device with the IDF and patch panel information. The labeling font need to be large enough that it can be read by a person who may be ground level but the device is mounted on a wall or ceiling.
Labeling of outlets example

Comm. Room ID in Window

IDF1

Rack Numbers, Panel Letter & Port Number above jack

R1-A01
R1-A02

R1-B01
R1-B02

R1-H23
R1-H24

R2-A01
R2-A02

R2-B01
R2-B02

Rack Numbers, Panel Letter & Port Number above jack

COMMUNICATIONS CABLES

COMMUNICATIONS CABLES
E. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.7 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer’s limitations on bending radii. Provide and use lacing bars and distribution spools.

3.8 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.
3.9 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping." Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.10 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-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 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.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:


2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Testing UTP Cables and Links

1. All UTP cabling will be certified to meet and or exceed the specifications as set forth in the Link Performance Testing Specifications in the Transmission Performance Specifications for Field-Testing Of Unshielded Twisted-Pair Cabling Systems, TIA/EIA 568-B.2-1 (current draft) using a level III field tester. Certifications shall include the following parameters for each pair of each cable installed (parameters shall be tested up to a frequency sweep of 500 MHz):
a. Wire map (pin to pin connectivity)
b. Length (in feet)
c. Attenuation
d. Near End Crosstalk (NEXT)
e. Far End Crosstalk (FEXT)
f. ELFEXT
g. Attenuation/Crosstalk Ration (ACR)
h. Return Loss
i. Propagation Delay
j. Delay Skew
k. Test equipment shall provide an electronic and printed record of these tests. Test equipment shall be a Fluke Networks DTX-1200 or Fluke Networks DTX-1800 tester.
l. Owner reserves the right to hire an independent testing company to spot check the test results. If the results vary more than 10% from the results provided by the Contractor, the Contractor will be required to prove his results are correct or retest the entire system.
m. If test is using a Fluke tester (2071 or 1071) to guarantee accuracy and correct NVP is entered in tester.

2. Optical Fiber Cable Tests:
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568.C. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:
      1) Horizontal and singlemode backbone link measurements: Test at 1310 or 1550 nm in 1 direction according to TIA/EIA-568.C, Method B, One Reference Jumper.
      2) The Optical Fiber Link Loss Budget used for testing the Fiber backbone cabling should be determined by utilizing the CommScope Link Loss Calculator. This value should be entered into the Testing Equipment to accurately test the fiber backbone.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Immediate fix of that cable and apparatus shall be done if it fails the test. Do not move onto next cable until that failed cable has a passing test.

H. Prepare test and inspection reports.

3.12 AS-BUILT DRAWINGS
A. The Cabling Contractor shall provide three sets of As-Built drawings to the Owner, which clearly indicates:

1. A floor plan of the building showing the AS-Built location of data drops, conduit runs, and terminal cabinets.

2. A listing of all stations with each data drop clearly identified according to system labeling scheme. Show all ports and punchdowns.

END OF SECTION 271300
PART I - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes equipment for public address and sound systems.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. Zone: A separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 WORK INCLUDED

A. System Functions: Include the following:
   1. Amplifiers
   2. Ceiling speakers
   3. Suspended speakers
   4. Equipment Racks
   5. VOIP Interface Units
   6. Wiring for Equipment and final connection of speakers
   7. Test, operational and demonstration of system operation.

1.5 SUBMITTALS

A. Product Data: For each type of equipment.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection. Include control panel layouts and wiring diagrams.

C. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this section.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.

C. Comply with the NEC.

D. Comply with UL 50.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Shall integrate with existing Berbee Infocast IP paging system.

2.2 EQUIPMENT

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Modular type, using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Amplifiers: Bogen V250 series power amplifier, 70V output, 250W with rack mounting kit. Provide quantity as required for system operation plus 50% spare capacity.

D. IP Ceiling speakers: Valcom VIP-120, 8 inch round speaker, white baffle, flush mounted. Provide quantity as indicated on the plans.

E. IP speaker clock combination units: Valcom VIP-412-DF flush mounted. Provide quantity as indicated on the plans.

F. IP Surface speakers: Valcom VIP-120, 8 inch round speaker, white baffle. Provide and install V-9816M back box, paint white. Provide quantity as indicated on drawings.

G. VOIP Interface unit: Atlas Soundolier IPS-ZC2 VOIP interface. Rack mounted

E. Equipment Rack: Comply with EIA-310-D. House amplifiers and auxiliary equipment in standard EIA 19-inch racks with the telecommunications equipment.

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically.
3. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
4. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
5. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
7. Power-Control Panel: On front of equipment housing, with a master power on/off switch and pilot light, and socket for a 5-A, indicating, cartridge fuse for rack equipment power.
8. Service Light: At top rear of rack and control by an adjacent switch.
9. **Vertical Plug Strip:** Grounded receptacles, 12 inches on center the full height of rack, to supply rack-mounted equipment.

10. **Maintenance Receptacles:** Duplex convenience outlets supplied independent of equipment plug strip and located in front and bottom rear of rack.

11. **Spare Capacity:** 20 percent spare space capacity in rack for future equipment.

**J. Cable and Conductors:** Jacketed, twisted-pair and twisted-multipair, untinned, solid-copper conductors.

1. **Insulation for Wire in Conduit:** Thermoplastic, not less than 1/32 inch thick.

**PART 3 - EXECUTION**

3.1 **INSTALLATION**

A. Install equipment to comply with manufacturer’s written instructions.

B. **Wiring Method:** Install wiring in raceway except within consoles, desks, and counters. Conceal cable and raceway except in unfinished spaces.

C. **Wiring within Enclosures:** Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

D. **Control-Circuit Wiring:** Install number and size of conductors as recommended by system manufacturer for control functions indicated.

E. **Separation of Wires:** Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

F. **Splices, Taps, and Terminations:** Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. **Match input and output impedances and signal levels at signal interfaces.** Provide matching networks where required.

H. **Identification of Conductors and Cables:** Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.

I. **Wall-Mounting Outlets:** Flush mounted.

J. **Conductor Sizing:** Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

K. **Weatherproof Equipment:** Install units that are mounted outdoors, in damp locations, or where exposed to weather consistent with requirements of weatherproof rating.

L. **Line Matching Transformer Connections:** Make initial connections using tap settings indicated on Drawings.
M. Provide and install all hardware required to integrate paging system with VOIP interface in the equipment rack. All interface connections shall be coordinated and completed in accordance with manufacturers requirements.

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.3 FIELD QUALITY CONTROL

A. Operational Test: Perform tests that include originating program and page material at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and freedom from noise and distortion. Correct deficiencies and retest, if required.

B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner’s maintenance personnel to adjust, operate, and maintain equipment.

1. Train owner’s maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.

2. Review data in maintenance manuals.

END OF SECTION 275116
SECTION 275313 – CLOCK SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes equipment for clock systems.

1.3 DESCRIPTION

A. System shall be a centrally controlled master time system, UL listed.

B. System shall be fully installed, programmed, and tested.

1.4 SUBMITTALS

A. Product Data: For each type of equipment.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location of each field connection. Include control panel layouts and wiring diagrams.

C. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this section.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.

C. Comply with the NEC.

D. Comply with UL 50.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Receive equipment at job site and verify components and quantity delivered.
B. Handle equipment to prevent internal components damage and breakage.

C. Equipment found to be damaged shall not be installed.

D. Store equipment in a clean, dry space and protect from dirt, fumes, water, construction debris and physical damage.

E. After installation, protect equipment from damage by work of other trades.

PART 2 - PRODUCTS

2.1 SYSTEM OPERATION

A. Paging Head end system is existing Berbee Infocast IP paging system refer to specification system 275116.

B. IP Clocks:
   1. Ceiling mount double sided hall clock, 4 inch, 4 digit : Valcom VIP-D440DS.
   2. Class room speaker clock combination unit, with 2.5 inch, 4 digit clock: Valcom VIP-412-DF
   3. Clock back boxes shall be provided by the clock manufacturer.
   4. All clocks shall be equipped to operate with and be synchronized by the network server.
   5. All clocks shall be grounded per the manufacturer’s instructions and the NEC.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which clock system is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install equipment to comply with manufacturer’s written instructions.

B. Wiring Method: Install wiring in raceways. Install conduit and conductors per Sections 260519 and 260533.

C. All wires shall be tagged at all junction points and shall test free from grounds or crosses between conductors. Final connections in master time control center shall be made under the supervision of the manufacturer’s service technician.

3.3 ADJUSTMENT AND CLEANING

A. Clean system equipment and enclosures of dirt and debris at time of installation.

3.4 TESTING
A. The completed system shall be fully tested by the contractor in the presence of the owner. Upon completion of a successful test, the contractor shall so certify in writing to the owner.

END OF SECTION 275313
SECTION 1283100 – FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes fire alarm system modifications and smoke detection systems.

1.3 RELATED WORK
   A. The scope of work is to include any required modifications to the existing Siemens fire alarm system, the addition of pull stations, horn/strobes, smoke detectors, as indicated on the drawings. The modifications are to include all required notification appliance circuit (NAC) panels, fire alarm system programming, addressable modules as well as any required hardware and software to provide a complete and functional system.

   B. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced fire alarm systems:

   2. Section 260526 – Grounding.
   3. Section 260519 - Conductors and Cables.
   4. Section 260533 – Raceways and Boxes.

   C. CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

1.4 REGULATORY REQUIREMENTS AND REFERENCES
   A. The system shall be Underwriter’s Laboratories Inc. (UL) listed.

   B. Factory Mutual (FM) Research Corporation, FM approval guide listed.

   C. Conform to the current version of the International Building Code (IBC).

   D. Conform to the current version of the International Fire Code (IFC).

   E. Conform to current version of the National Fire Alarm Code (NFPA 72).

   F. Conform to current version of the National Electrical Code (NFPA 70).

   G. Department of Justice 28 CFR Part 36, Americans with Disabilities Act (ADA).
H. Federal, state, and local codes, and authority having jurisdiction.

1.5 SYSTEM DESCRIPTION
A. The existing SIEMENS MXL fire alarm control panel is to be programmed to all the following changes: monitor all of the existing initiation and new initiation devices. The new horn/strobes are to be connected to the existing or new NAC circuits as required.

1.6 WARRANTY
A. The Contractor shall warrant all equipment and systems for a period of 1-year following acceptance of system by the Owner’s representative. The warranty shall include parts, labor, prompt field service, pickup, and delivery.

1.7 QUALIFICATIONS
A. The system and components shall be supplied by a manufacturer of established reputation and experience which has produced similar apparatuses for a period of at least 3 years, and is able to refer to similar installations rendering satisfactory service.

B. The fire alarm system contractor shall be fully responsible for the procurement, and installation of all fire alarm system conduits, mounting hardware, miscellaneous hardware and wiring including panels and devices to form a complete working system.

C. Installation of conduit, field wiring, labeling, mounting of control panels and field devices shall be done by a person or persons who possess a valid state of Idaho journeyman’s or master’s electricians license and shall have verifiable experience in the installation of fire alarm systems in similar facilities. Installation of fire alarm control panels and shall be done under the direct supervision of the manufacturer or manufacturer’s representative.

D. Installation of all internal components in control panels, wiring of control panels, and system testing shall be done by the manufacturer or manufacturer’s representative at the completion of the project.

1.8 SUBMITTALS
A. Provide the following within 4 weeks after award of Subcontract:

1. Any required additions, modifications, or additional details necessary to create or complete the following construction documentation:
   a. Plan view drawings showing location of all equipment, all panels, and all field devices.
   b. Plan view drawings showing intended raceway routing sizes and percentage cable fill for all required fire alarm systems.
   c. Signal circuit voltage drop and battery calculations.

2. Deviations from the Drawings shall be noted on a marked drawing set submitted by the Contractor. Red shall be used for additions, green for deletions, and blue for notes to drafter.

C. The system vendor shall submit a proposal for recommended spare parts, quantities, and cost.
D. Installation shall not proceed until the Owner’s representative has reviewed submittals for general conformance with the intent of the Specifications.

E. Provide as-built blue-line markups 1 week after acceptance test.

1.9 OPERATION AND MAINTENANCE

A. Provide four copies of operation and maintenance manuals to Owner’s maintenance personnel 1 week prior to system acceptance by Owner’s representative.

B. Manuals shall consist of:

1. Bill of material.
2. Product catalog cut sheets.
3. Product schematics, nonproprietary.
4. Plan View Drawings Showing:
   a. Control panels and device locations.
   b. Size and type of conduit and raceways.
   c. Size, type, color, and number of conductors and cabling in conduit and raceways.

5. Control Panel Assembly Drawings Showing:
   a. Module layout.
   b. Interconnecting wiring.
   c. Wire and cable tag numbers.
   d. Wire size, type, and color.

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT

A. All materials, equipment, accessories, and other facilities and appurtenances covered by these Specifications or noted on the Contract drawings and on the Contractor’s approved working drawings and installation specifications shall be new unless otherwise noted, best suited for their intended use, and shall conform to the applicable and recognized standards for the use.

1. Manual addressable fire pull boxes shall be dual action and listed by Underwriters’ Laboratories, Inc. The intelligent manual fire station shall operate on any addressable detection circuit. It shall be red in color. Manual fire stations shall be individually annunciated on the control panel. Mounting height shall be as indicated on the project drawings.

2. Intelligent/analog smoke detectors shall be photoelectric and listed by Underwriters’ Laboratories, Inc. The detector shall contain a long life light emitting diode (LED) as its light source, and photo diode as a light receiver. An automatic gain control circuit shall be compensating for detector aging and dirt accumulation. Each smoke detector, when activated, shall have a flashing tri-color LED alarm indicator that shall indicate red for alarm, yellow for trouble and green for normal operational mode. Application Specific Detection environmental settings shall be programmed as directed by the engineer. System programming shall provide multiple out-put functions from a single initiating address device. Systems not capable of providing this design requirement shall provide alternate programmable logic accomplishing design performance, acceptable to the engineer of record.
3. It shall be possible to adjust and/or electronically measure the sensitivity of each individual intelligent analog smoke sensor from the control panel. Relative sensitivity or manual test methods, which check the smoke sensor at the maximum allowable obscuration, will not be considered as being equivalent.

4. Duct smoke detectors shall be photoelectric and listed by Underwriters’ Laboratories, Inc. Each smoke sensor and air duct housing shall be self-compensating for the effects of air velocity (from 300 to 4,000 FM), temperature, humidity and atmospheric pressure. It shall not be necessary to field adjust the sensitivity to compensate for the above effects. Each smoke sensor shall utilize solid state components and be equipped with an integral alarm indicating LED which shall flash when the smoke sensor is activated and shall also provide a form “C” remote relay with contacts rated at 3 AMPS, 120 VAC resistive or 24 VDC resistive.

5. Smoke detectors shall alarm at their programmed sensitivity settings and shall not revert to a common default setting when their operating system segment is in the fail safe degrade mode.

6. Horns shall be of sufficient number so that an alarm shall be clearly audible to all occupants of the building and/or fire area, as required by these specifications. Mounting height shall be as indicated on the project drawings. Locations where ceilings prevent the installation at the height indicated on the project drawings, the centerline of the unit shall be 6” inches below the ceiling.

7. Audible alarm signals shall produce a sound level at least 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of at least 60 seconds (whichever is greater) measured 5 feet above the floor in each occupiable area. The average ambient sound level is the root mean square, a weighted sound pressure measured over a 24-hour period.

8. Strobes shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. All strobes shall be synchronized.
   a. Strobes shall produce a flash rate of one (1) flash per second minimum over the listed input voltage (20VDC-31VDC) range.
   b. Strobes shall incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid state circuitry.
   c. Strobe intensity shall be rated per UL 1971 for 15/75, 30/75, 60/75, 75 or 110 Candela. Dual listing strobes of 15/75 intensity for UL 1971/near-axis requirements shall be used where acceptable.
   d. Strobes shall be available for semi-flush or surface mounting and in conjunction with audible appliances as required.
   e. All strobes shall be synchronized throughout the facility.

9. The system shall provide status indicators and control switches for all of the following functions:
   a. Audible and visual evacuation alarm circuit zone control.
   b. Any additional status or control functions as indicated on the drawings, including but not limited to, emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.
   c. Fire and/or smoke dampers.

2.2 CONTRACTOR’S RESPONSIBILITY

A. The Contractor is responsible for supplying adequate hardware to satisfy the design requirements of all work included under this Section.

B. Verification Testing:

1. The Contractor, with the aid of a factory-trained technician, shall inspect, test, and adjust the complete fire alarm system before notifying the Owner’s representative that the system is ready.
for acceptance testing. He shall visually inspect all equipment and components, wiring, and conduit runs and verifies all inputs and outputs, audible and visual alarms, control panels, and central monitoring.

C. Acceptance Testing:

1. The Owner’s acceptance testing will only be done after the verification testing has been completed by the Contractor and necessary documentation has been given to the Owner’s representative. The Owner’s acceptance testing will be the same as for verification testing and shall be performed in the presence of the Owner’s representative, the Contractor, a factory-trained technician and the authority having jurisdiction. The Contractor shall coordinate scheduling for the acceptance test and shall develop and submit the acceptance test documentation to the Engineer and Owner for review 5 days prior to acceptance test date. The testing will be conducted on off-hours or over holidays and must be scheduled accordingly.

D. Contractor shall coordinate the schedule of the system vendor’s technicians to provide detailed wiring of equipment on a continuous basis.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer’s recommendations. All wiring will be installed in conduit and be in strict compliance with all provisions of the current issue of NEC ARTICLE 760 A and C, Power limited Fire Protective Signaling Circuits or if reclassified as non-power limited and then wired in accordance with NEC ARTICLE 760 A and B.

B. All junction boxes shall be sprayed red and labeled “Fire Alarm”. Wiring color codes are specified on the drawings.

C. Label each end of cable (wire), detectors, manual pull stations, and horn strobes.

D. Conduit shall be marked at 10-foot intervals or closer with 3-inch wide red/white adhesive tape.

E. Install manual fire alarm stations with operating handle 48 inches above floor. Install wall-mounted audible and visual indicating devices at 80 inches above the finished floor to the bottom of device.

F. Mount the end-of-line device with the last device on the circuit or in a separate box adjacent to last device on the circuit.

G. Install all equipment, components, conduit, and conductors such that the coordination integrity of all utility installations are maintained.

H. All cabling, interconnecting wiring, conduit, junction boxes, and raceways shall be labeled with an identification tag.

I. All conductors, cabling, and interconnecting wiring shall be in accordance with Section 260519, Conductors and Cables.

J. All conduit and raceways shall be in accordance with Section 260533, Raceways and Boxes.
K. All conduit, junction boxes, and raceways shall be sized per the current issue of the NEC with additional 45 percent future expansion capacity.

L. Individual system's cabling and interconnection wiring shall be installed in conduit, junction boxes, and raceways dedicated to that system only.

M. All 120-Vac wiring required for fire alarm systems shall be installed in completely separate and dedicated conduit, junction boxes, and raceway from any other systems.

N. Minimum size of all fire alarm system conduit shall be 3/4 inch.

O. All wiring and cabling between field devices and field devices, field devices and panels, panels and panels, and any other equipment to equipment shall be home run and splicing shall not be allowed.

P. All intrinsically safe systems shall be installed per requirements of the NEC, Article 504.

Q. Installation of 120-Vac supply from panel board to control and NAC panel(s) shall be in accordance with:
   
   2. Section 260526 – Grounding.
   3. Section 260519 - Conductors and Cables.
   4. Section 260533 – Raceways and Boxes.

3.2 FIELD QUALITY CONTROL

A. Test all material, equipment, and fire alarm systems in accordance with manufacturer's recommendations, current issue of NFPA, and applicable codes.

B. Provide Owner with record drawings, documentation of systems test and sign-off, including written statement of completion.

END OF SECTION 283100