PROJECT MANUAL FOR:
MIZZOU SPORTS ARENA - RENOVATE BASKETBALL SPACES  VOLUME 2 OF 2

PROJECT NUMBER: CP200131

AT
UNIVERSITY OF MISSOURI – COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

HELLMUTH, OBATA & KASSABAUM, INC.
300 W. 22nd Street
Kansas City, Missouri 64108

DATE: March 03, 2020

I hereby certify that these Drawings and/or Specifications have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: __________________________

2-27-20
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<td>23 33 00</td>
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<td>23 36 00</td>
<td>Air Terminal Units</td>
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<td>23 37 13</td>
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<td>27 05 00</td>
<td>Common Work Results for Communications</td>
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SECTION 230010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.
1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>IBC</td>
<td>International Building Code</td>
</tr>
<tr>
<td>IMC</td>
<td>International Mechanical Code</td>
</tr>
<tr>
<td>IPC</td>
<td>International Plumbing Code</td>
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<tr>
<td>ASHRAE</td>
<td>90.1</td>
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<td>IFC</td>
<td>International Fire Code</td>
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<tr>
<td>IFGC</td>
<td>International Fuel Gas Code</td>
</tr>
<tr>
<td>ADA</td>
<td>American Disabilities Act</td>
</tr>
<tr>
<td>ADC</td>
<td>Air Diffusion Council</td>
</tr>
<tr>
<td>AMCA</td>
<td>Air Movement and Control Association, Inc.</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AHRI</td>
<td>Air Conditioning, Heating and Refrigeration Institute</td>
</tr>
<tr>
<td>ASHRAE</td>
<td>American Society of Heating Refrigerating and Air Conditioning Engineers</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASSE</td>
<td>American Society of Sanitary Engineering</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society of Testing Materials</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
</tr>
<tr>
<td>CISPI</td>
<td>Cast Iron Soil Pipe Institute</td>
</tr>
<tr>
<td>ETL</td>
<td>Electrical Testing Laboratories</td>
</tr>
<tr>
<td>FGI</td>
<td>Facilities Guideline Institute</td>
</tr>
<tr>
<td>HI</td>
<td>Hydraulic Institute</td>
</tr>
<tr>
<td>MSS</td>
<td>Manufacturer's Standardization Society of the Valve and Fitting Industry</td>
</tr>
<tr>
<td>NBFU</td>
<td>National Board of Fire Underwriters</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers' Association</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Act</td>
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<tr>
<td>PDI</td>
<td>Plumbing and Drainage Institute</td>
</tr>
<tr>
<td>SMACNA</td>
<td>Sheet Metal and Air Conditioning Contractors National Association, Inc.</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriter's Laboratories</td>
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</table>
E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”

2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”

3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use.”

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

B. The terms "approved equal", “equivalent”, or “equal” are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing
materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.

3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

6. Building Fill: Building fill as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in
establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in Table 1 at the end of this Section. Provide the number of submittals required by Division 01; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

F. Refer to individual Sections for additional submittal requirements.

G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

I. Submittals shall contain the following information:
1. The project name.

2. The applicable specification section and paragraph.

3. Equipment identification acronym as used on the drawings.

4. The submittal date.

5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

6. Submittals not so identified will be returned to the Contractor without action.

J. Refer to Division 01 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer’s designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

L. Provide welders’ qualification certificates.

1.8 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect’s written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect’s written authorization and Engineer’s release agreement form must be received before electronic drawing files will be sent.

1.9 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.
B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
   a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
   b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
   c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
   d. Same warranty will be furnished for proposed substitution as for specified Work.
   e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
   f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.
1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer’s review, and for the Owner’s use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in Table 5.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer’s designated representative.

1.11 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification. Refer to Table 2 at the end of this Section for a list of specification sections in Division 23 that contain spare parts requirements.

B. Owner or Owner’s representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.12 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these
drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.13 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.14 PAINTING

A. Exposed ductwork and ferrous surfaces, including pipe, pipe hangers, equipment stands and supports and exposed insulated piping shall be painted by the Contractor using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.16 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's
standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.
2. Insulation shall be effective.
3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 23 that contain special warranties.

1.17 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

1.18 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting his bid to determine the nature and extent of work involved.

2. Work in the existing building shall be scheduled with the Owner.

3. Certain demolition work must be performed prior to the remodeling. The Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.

4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become his property and shall be removed by the Mechanical Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.

5. Mechanical Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
6. General Contractor shall install finish material.

7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

D. Use of explosives is not permitted.

E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.
3.2 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.3 SELECTIVE DEMOLITION

A. Refer to Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

   1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.

      a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

      b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.

F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.4 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.5 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.6 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.

2. Submit complete Record Drawings.

3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 23 that contain special inspection requirements.

4. Start-up testing of systems.

5. Removal of temporary facilities from the site.

6. Comply with requirements for Substantial Completion in the "General Conditions".
B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a “final list” of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION
### TABLE 1: MECHANICAL SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

<table>
<thead>
<tr>
<th>SPECIFICATION NUMBER/TITLE</th>
<th>CODE DESIGNATION</th>
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</thead>
<tbody>
<tr>
<td>230010 General Mechanical Requirements</td>
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<tr>
<td>230015 Electrical Coordination for Mechanical Equipment</td>
<td>NONE</td>
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<tr>
<td>230500 Common Work Results for HVAC</td>
<td>A, B, G, N</td>
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<tr>
<td>230510 Basic Piping Materials and Methods</td>
<td>B, G</td>
</tr>
<tr>
<td>230513 Common Motor Requirements for HVAC Equipment</td>
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<tr>
<td>230519 Meters and Gauges for HVAC Piping</td>
<td>B, H</td>
</tr>
<tr>
<td>230523 General-Duty Valves for HVAC Piping</td>
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</tr>
<tr>
<td>230529 Hangers and Supports for HVAC Piping and Equipment</td>
<td>B, F, G, H</td>
</tr>
<tr>
<td>230550 Vibration Isolation for HVAC</td>
<td>A, B, C, F, I</td>
</tr>
<tr>
<td>230553 Identification for HVAC Piping and Equipment</td>
<td>B, L, N</td>
</tr>
<tr>
<td>230593 Testing, Adjusting and Balancing For HVAC</td>
<td>H, J</td>
</tr>
<tr>
<td>230700 HVAC Insulation</td>
<td>B, L</td>
</tr>
<tr>
<td>230800 Commissioning of HVAC Systems</td>
<td>C, J</td>
</tr>
<tr>
<td>230923 Direct-Digital Control for HVAC</td>
<td>A, B, C, D, E, F, J, K, L, N, O, Q</td>
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<tr>
<td>232113 Hydronic Piping</td>
<td>B, C, D, F, G, H, J</td>
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<tr>
<td>232116 Hydronic Specialties</td>
<td>A, B, C, F, G, H</td>
</tr>
<tr>
<td>232123 Hydronic Pumps</td>
<td>A, B, C, E, F</td>
</tr>
<tr>
<td>233113 Metal Ducts</td>
<td>A, B, D, G</td>
</tr>
<tr>
<td>233300 Air Duct Accessories</td>
<td>A, B, F, Q</td>
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<tr>
<td>233600 Air Terminal Units</td>
<td>A, B, C, E, F</td>
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<tr>
<td>233713 Diffusers, Registers, and Grilles</td>
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<tr>
<td>238419 Swimming Pool Air Handling Units</td>
<td>A, B, C, E, F, K, Q</td>
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### CODED LEGEND

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<tr>
<th>Code</th>
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<tr>
<td>A</td>
<td>Shop Drawings</td>
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<td>B</td>
<td>Product Data</td>
</tr>
<tr>
<td>C</td>
<td>Performance Data, Capacities, Curves and Certificates</td>
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<td>D</td>
<td>Coordination Drawings</td>
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<td>E</td>
<td>Wiring Diagrams</td>
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<td>Installation Instructions</td>
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<td>G</td>
<td>Welder’s Certificates</td>
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<td>P</td>
<td>Material List</td>
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<td>Q</td>
<td>Recommended Spare Parts List</td>
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### TABLE 2: SPARE PARTS REQUIREMENTS FOR MECHANICAL EQUIPMENT

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<thead>
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<tr>
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<td>232116</td>
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<td>232123</td>
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<td>233300</td>
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<td>Diffusers, Registers, and Grilles</td>
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<tr>
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<td>Swimming Pool Air Handling Units</td>
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Owner’s Signature
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<tr>
<td>230550</td>
<td>Vibration Isolation for HVAC</td>
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TABLE 5: MECHANICAL SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

<table>
<thead>
<tr>
<th>SPECIFICATION NUMBER/TITLE</th>
<th>CODE DESIGNATION</th>
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<tr>
<td>230519 Meters and Gauges for HVAC Piping</td>
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<td>230529 Hangers and Supports for HVAC Piping and Equipment</td>
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<td>230550 Vibration Isolation for HVAC</td>
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<td>230553 Identification for HVAC Piping and Equipment</td>
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<tr>
<td>230593 Testing, Adjusting and Balancing for HVAC</td>
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<tr>
<td>230700 HVAC Insulation</td>
<td>B</td>
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<td>230800 Commissioning of HVAC Systems</td>
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<td>B, C, D, E, G, H, I</td>
</tr>
</tbody>
</table>

CODED LEGEND

A  As-Built Drawings
B  Product Data
C  Performance Data, Capacities, Curves and Certificates
D  Wiring Diagrams
E  Operating Instructions
F  Test Reports
G  Warranties
H  Recommended Spare Parts List
I  Service and Maintenance Instructions
SUBSTITUTION REQUEST FORM

To Project Engineer: ___________________________ Request # (GC Determined): ________________

Project Name: ______________________________________________________________________

Project No/Phase: ___________________________ Date: ___________________________

Specification Title: __________________________________________________________________

Section Number: ______________ Page: _______ Article/Paragraph: ________

Proposed Substitution: __________________________________________________________________

________________________________________________________________________

Manufacturer: ___________________________ Model No.: ___________________________

Address: ___________________________ Phone: ___________________________

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

Differences between proposed substitution and specified Work: ___________________________

________________________________________________________________________

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: ______________

Reason for not providing specified item: ___________________________

________________________________________________________________________

Similar Installation:
Project: ___________________________ Architect: ___________________________

Address: ___________________________ Owner: ___________________________

Date Installed: ___________________________

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: ___________________________

________________________________________________________________________

GENERAL MECHANICAL REQUIREMENTS 230010-20
Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

__________________________  ____________________________  ____________________________
Submitting Contractor                        Date                        Company

Manufacturer’s Certification of Equal Quality:

I ____________________________ represent the manufacturer of the Proposed Substitution Item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

__________________________  ____________________________  ____________________________
Manufacturer’s Representative                        Date                        Company

Engineer Review and Recommendation Section

Recommend Acceptance  □ Yes  □ No

Additional Comments:  □ Attached  □ None

Acceptance Section:

__________________________  ____________________________  ____________________________
Contractor Acceptance Signature                        Date                        Company

__________________________  ____________________________  ____________________________
Owner Acceptance Signature                        Date                        Company

__________________________  ____________________________  ____________________________
Architect Acceptance Signature                        Date                        Company

__________________________  ____________________________  ____________________________
Engineer Acceptance Signature                        Date                        Company
SECTION 230015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, “COMMON WORK RESULTS FOR ELECTRICAL” for specification of motor connections.

C. Refer to Division 26, “ENCLOSED CONTROLLERS“ for specification of motor starters.
D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.
### TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FURN</th>
<th>SET</th>
<th>POWER</th>
<th>CONTROL</th>
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<tr>
<td></td>
<td>BY</td>
<td>BY</td>
<td>WIRING</td>
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<td>Equipment motors</td>
<td>DIV23m</td>
<td>DIV23m</td>
<td>DIV26</td>
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<tr>
<td>Factory furnished motor starters and disconnects</td>
<td>DIV23m</td>
<td>DIV23m</td>
<td>DIV26</td>
<td>DIV23t</td>
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<td>Loose motor starters, disconnect switches, thermal overloads and heaters.</td>
<td>DIV26</td>
<td>DIV26</td>
<td>DIV26</td>
<td>DIV23t</td>
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<tr>
<td>Control relays</td>
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<td>DIV23t</td>
<td>DIV26</td>
<td>DIV23t</td>
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<td>Thermostats (low voltage)</td>
<td>DIV23t</td>
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<td>Thermostats (line voltage)</td>
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DIV23m = Mechanical Contractor  
DIV23t = Temperature Controls Sub-Contractor  
DIV26 = Electrical Contractor  
DIV28 = Electronic Safety and Security

END OF SECTION
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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:

1. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

2. Mechanical equipment nameplate data.

3. Non-shrink grout for equipment installations.

4. Sleeves for mechanical penetrations.

5. Drip Pans with detection.

6. Miscellaneous metals for support of mechanical materials and equipment.

7. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.

8. Joint sealers for sealing around mechanical materials and equipment.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 07 Section “Penetration Firestopping” for material and methods for firestopping systems.

2. Division 23 Section “Basic Piping Materials and Methods,” for materials and methods for mechanical sleeve seals.

3. Division 23 Section “Direct Digital Controls for HVAC” for integration with building automation system of leak detection system “Water Present” alarm.

4. Division 26 Section “Common Work Results for Electrical” required electrical devices.

5. Division 26 Sections “Enclosed Switches and Circuit Breakers” for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.

1. Product data for the following products:
a. Access panels and doors.

b. Joint sealers.

c. Through and membrane-penetration firestopping systems.

2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.

3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:
   1. Bar-Co., Inc.
   2. Elmdor Stoneman.
   3. JL Industries
   6. Milcor
   7. Nystrom Building Products
   8. Wade
   9. Zurn

B. Access Doors:
   1. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
   2. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
      a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
      b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
      c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
   3. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
      a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
2.2 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 GROUT

A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.4 PENETRATIONS

A. Sleeves:
   1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
   2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.5 DRIP PANS

A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2” lapped and soldered joints. Drip pan shall have a depth of 2” and a width of 6” in addition to the diameter of the associated pipe. Provide 3/4” galvanized pipe with male NPT outlet at low point of drip pan. Connect ¾” type “L” copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.

B. Drip pan supports shall be ¼” X 2” galvanized bar stock welded to the drip pan without holes. Provide ¾” galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.

C. Flood Detector: Flood detector switch utilizing hydrophilic pad and stainless steel sensor array to detect moisture. Switch shall be provided with integral feet to prevent pad from contacting the
pan. Provide with solid state electronics and double throw relay to allow switch to shut down unit and provide an auxiliary alarm output.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Diversitech or approved equivalent

2.6 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
B. Cold-Formed Steel Tubing: ASTM A 500.
C. Hot-Rolled Steel Tubing: ASTM A 501.
E. Fasteners: Zinc-coated, type, grade, and class as required.

2.7 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.8 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
B. Colors: As selected by the Architect from manufacturer's standard colors.
C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

1. Manufacturers:
   a. Dow Corning, Dowsil 790.
   b. Dow Corning, Dowsil 795.
   c. GE, Silglaze II SCS 2350.
   d. GE, Silpruf SCS 2000.
   e. Owens Corning, Energy Complete.
f. Pecora, 864 NST.
g. Tremco, Spectrem 1.
h. Tremco, Spectrem 2.

D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

1. Manufacturers:
   a. Dow Corning, Dowsil 786.
   b. GE, Momentum SCS1700.
   c. Pecora, 898 Silicone NST.

E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.

1. Manufacturers:
   a. BASF, MasterSeal NP 100.
   b. Pecora, DyanTrol I-XL.
   c. Tremco, Dymonic FC.

F. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Manufacturers:
   a. Pecora, AC-20
   b. Sherwin Williams 950A
   c. Tremco, Tremflex 834

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.
3.2 INSTALLATION OF ACCESS DOORS

A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section “Identification for HVAC Piping and Equipment” for labeling of access doors.

B. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

C. Access doors must be of the proper construction for type of construction where installed.

D. The exact location of all access doors shall be verified with the Architect prior to installation.

E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

F. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.


B. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.

H. Cut sleeves to length for mounting flush with both surfaces of walls.

I. Extend sleeves installed in floors 2 inches above finished floor level.

J. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

K. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

L. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section "Basic Piping Materials and Methods".
3.8 DRIP PANS

A. Provide drip pans in locations indicated on drawings.

B. Provide drip pans for piping or equipment installed over electrical panels in variance with the drawings. Obtain approval from the Architect prior to installation.

C. Provide drip pans for piping directly above a two hour rated ceiling of an elevator machine room.

D. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.

E. Provide drip pan supports every 4'-0”.

F. Install leak detection rope in a zig-zag pattern covering entire length and width of the drip pan. Secure rope to pan per manufacturers recommendations.

G. Mount leak detection controller on wall adjacent to exit of the room above which the drip pan is located unless otherwise indicated on drawings indicated on drawings.

H. Coordinate disconnect and power supply for leak detection system and 120V dedicated receptacle adjacent to controller with Division 26. Power wiring and receptacles are specified in Division 26 Section “Common Work Results for Electrical”. Disconnects are specified in Division 26 Section “Enclosed Switches and Circuit Breakers”

I. Place flood detector in the lowest location in the drip pan. Interlock detector with the HVAC equipment per manufacturer's recommendations.

J. Wire flood detector to remote alarm, Diversitech Universal Alarm or equivalent. Coordinate location of the remote alarm with building owner prior to installation.

K. Coordinate interlock of “Water Present” alarm and “Cable Fault” alarm with building automation system. Refer to Division 23 Section “Direct Digital Controls for HVAC” for integration with building automation system and low voltage power wiring.

3.9 PLENUM INSULATION

A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated plenums where permitted by the local authority having jurisdiction

B. Overlap: Provide a minimum 1” perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.

C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer’s written installation instructions.

D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated plenums where the use of plenum insulation is not approved.
END OF SECTION
SECTION 230510 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1  SECTION INCLUDES

A.  Joining materials.
B.  Nipples.
C.  Unions.
D.  Dielectric waterway fittings.
E.  Dielectric flanges and flange kits.
F.  Mechanical sleeve seals.

1.2  RELATED SECTIONS

A.  Division 23 Section "Common Work Results for HVAC," for materials and methods for sleeve materials.
B.  Division 26 Sections "Common Work Results for Electrical" and "Enclosed Controllers" for power-supply wiring including field-installed disconnects and required electrical devices.

1.3  SUBMITTALS

A.  Refer to Division 01 and Division 23 Section “General Mechanical Requirements” for administrative and procedural requirements for submittals.
B.  Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.
C.  Quality Control Submittals: Submit welders' certificates specified in Quality Assurance below.
D.  Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system in the project including manufacturer, pipe sizes, type, grade, schedule, and ASTM standard and connection method(s).
E.  Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.
F.  Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.
1.4 QUALITY ASSURANCE
A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPE AND FITTINGS
A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.2 JOINING MATERIALS
A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.
B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
C. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
D. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
E. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.
F. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.3 NIPPLES
A. Steel: ASTM A733, made of ASTM A53, Schedule 40, black steel; Type S seamless for pipe sizes 2 inch and smaller, Type E electric-resistance welded for pipe sizes 2-1/2 inch and larger.

2.4 UNIONS:
A. Manufacturers:
2.6 DIELECTRIC FLANGES AND FLANGE KITS
A. Manufacturers:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Pipeline Seal & Insulator, Inc.
4. Tampa Rubber & Gasket Co. Inc.
5. Watts Water Technologies.
6. Approved equal.
B. Full-faced gasket with same outside diameter and bolt hole arrangement as the flange. Conform to ANSI B16.5. Pressure rating of 200 psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180°F.

C. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

D. Flanges: Cast bronze meeting ASTM B584, class 125 solder type or cast iron meeting ASTM A536, class 125 threaded type for low pressure service, bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

2.7 MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. Thunderline/Link Seal.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Approved equal.

B. Sleeves: Refer to Division 23 Section “Common Work Results for HVAC” for sleeve materials.

C. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

J. Verify final equipment locations for roughing in.

K. Use fittings for all changes in direction and all branch connections.

L. Remake leaking joints using new materials.

M. Install components with pressure rating equal to or greater than system operating pressure.

N. Piping Protection:
   1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
   2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

O. Penetrations:
   1. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section “Common Work Results for HVAC” for additional penetration requirements.
   2. Above Grade Concrete or Masonry Penetrations:
      a. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.
         1) Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
         2) Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
3) Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

   a) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

   b) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

4) Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

   b. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

   c. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.

3. Elevated Floor Penetrations of Waterproof Membrane:

   a. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1 inch above finish floor. Size wall pipe for minimum 1/2 inch annular space between pipe and wall pipe.

   b. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

   c. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

   d. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."

   e. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

4. Interior Penetrations of Non-Fire-Rated Walls:

   a. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
b. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

5. Fire / Smoke Rated Floor and Wall Assemblies:
   a. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 07 Section “Penetration Firestopping” for special sealers and materials.

3.3 JOINTS

A. Steel Pipe Joints:
   1. Pipe 2 Inch and Smaller:
      a. Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

   2. Pipe Larger Than 2 Inch:
      a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.

      b. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

   2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.4 DIELECTRIC WATERWAY FITTINGS

A. Install dielectric waterway fittings for piping 2 inch and smaller for copper or brass pipe connections to carbon steel equipment connections.
3.5 DIELECTRIC FLANGES AND FLANGE KITS

A. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:
   1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:
   1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
   2. Install waterway fittings where installation is concealed. Do not install dielectric flanges in concealed spaces.

C. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.

D. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

E. Provide full face gasket with pressure rating equal to system served.

F. At each bolt provide steel washers, thermoplastic washers, and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.6 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION
SECTION 230513 - COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.
B. Applications.
C. Three phase electric motors.
D. Electronically Commutated Motors (ECM).
E. Capacitors.

1.2 REFERENCE STANDARDS

A. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings; most recent edition.
C. NEMA MG 1 – Motors and Generators; most recent edition.
D. NFPA 70 – National Electrical Code; most recent edition adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

1.3 SUBMITTALS

A. Conform with the submittal procedures in Division 01.
B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.
C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
E. Operation Data: Include instructions for safe operating procedures.
F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY STORAGE AND HANDLING.

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.6 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Baldor Electric Company.

B. General Electric.

C. Gould.

D. Marathon.

E. Regal-Beloit Corporation (Century).

F. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.

2. Motors 3/4 HP and Larger: Voltage as scheduled, three phase, 60 Hz.

B. Construction:

1. Open drip-proof except where noted otherwise.

2. Design for continuous operation in 104 degrees F environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.


C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 APPLICATIONS

A. Single phase motors for fans, pumps, blowers and air compressors: Capacitor start type.

B. Single phase motors for fans less than 2 hp and greater than 1/12 hp: Electronically commutated type.

2.4 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.

B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.

D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.5 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:
   1. Individual unit cells.
   2. All welded steel housing.
   3. Each capacitor internally fused.
   5. Craft tissue insulation.
6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.
### 3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

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### 3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

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END OF SECTION
SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

General

1.1 SECTION INCLUDES
   A. Pressure gauges and fittings.
   B. Thermometers and thermometer wells.
   C. Test plugs.
   D. Filter gauges.

1.2 REFERENCE STANDARDS
   A. Pressure Gauges and Gauge Attachments; 2013.
   E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2015.
   F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2012.
   G. AWWA C702 - Cold-Water Meters -- Compound Type; 2010.
   I. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
   J. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.3 SUBMITTALS
   A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
   B. Product Data: Provide schedule that indicates the following for each manufactured component:
      1. Model or figure number.
      2. Use.
      3. Rating.
      4. Operating range.
5. Total range.

6. Calibrated performance curves, certified where indicated.

7. Figure number.

8. Location.


C. Product Certificates: Signed by manufacturer certifying accuracy under specified operating conditions and product compliance with specified requirements.

D. Samples: Submit two of each type of instrument specified.

E. Project Record Documents: Record actual locations of components and instrumentation.

F. Operation and Maintenance Data: Furnish data for each manufactured component for inclusion in operating and maintenance manual.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Pressure Gauges: One of each type and size.

1.4 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers:


3. Dwyer Instruments, Inc.

4. H.O. Trerice Co.


6. Marshalltown Instruments, Inc.

7. Miljoco Corp.

8. Weiss Instruments, Inc.
9. Weksler Glass Thermometer Corp.
10. WIKA Instruments Corp.

B. Description: ASME B40.100, UL 393, rotary brass movement, white with black markings and black pointer.

C. Case: Drawn steel, cast aluminum, or stainless steel with phosphor bronze bourdon tube and front or rear recalibration adjustment. Provide silicone fluid damping where required by Part 3.

D. Size: 4-1/2 inch diameter.

E. Lens: Clear glass.

F. Stem: Brass for separable socket, length to suit installation.

G. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

H. Accuracy: Plus or minus 1 percent of range span.

I. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.2 PRESSURE GAUGE TAPPINGS

A. Manufacturers: Same as pressure gauge manufacturers.

B. Gauge Cock: Tee or lever handle, brass, rated for system pressure.

C. Needle Valve: Brass, 1/4 inch NPT, rated for system pressure.

D. Pulsation Damper: Pressure snubber, brass with 1/4 inch threaded connections, corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

E. Syphon: Brass, 1/4-inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc.
   2. H.O. Trerice Co.
   3. Marsh Instruments, Inc.
   4. Miljoco Corp.
   5. Weiss Instruments, Inc.
   6. Weksler Glass Thermometer Corp.
7. Winters Instruments.

B. Thermometers - Adjustable Angle:

1. Description: Red- or blue-appearing non-toxic liquid in glass tube; ASTM E1.

2. Adjustable Joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.


4. Size: 9 inch scale.

5. Window: Clear Lexan.

6. Stem: Brass, copper-plated steel, or aluminum for separable socket, length to suit installation.

7. Scale: Progressive, satin-faced, non-reflective aluminum, with permanently etched markings.

8. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

9. Calibration: Degrees F.

2.4 DIAL THERMOMETERS

A. Thermometer – Direct Mount, Bimetal Actuated:

1. Manufacturers:


   b. H.O. Trerice Co.

   c. Marshalltown Instruments, Inc.

   d. Miljoco Corp.

   e. Tel-Tru Manufacturing Co., Inc.

   f. Weiss Instruments, Inc.

   g. Weksler Glass Thermometer Corp.

   h. Winters Instruments.

2. Description: Dial type, ASTM E1 bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer.
3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

4. Case: Stainless steel with front or rear recalibration.

5. Size: 5 inch diameter dial.


7. Stem: Stainless steel for separable socket. Length to suit installation.


9. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. Calibration: Degrees F.

B. Thermometers – Direct Mount, Vapor Actuated:

2. Manufacturers:
   b. H.O. Trerice Co.
   c. Miljoco Corp.
   d. Weiss Instruments, Inc.
   e. Weksler Glass Thermometer Corp.
   f. Winters Instruments.

2. Description: Dial type vapor or liquid actuated; ASTM E1; copper bulb, copper or phosphor bronze bourdon tube, white with black markings and black pointer.

3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.


5. Size: 4-1/2 inch diameter dial.


7. Stem: Brass, copper-plated steel, or aluminum for separable socket. Length to suit installation.

9. **Accuracy:** Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. **Calibration:** Degrees F.

C. **Thermometers – Remote Reading:**

3. **Manufacturers:**
   b. H.O. Trerice Co.
   c. Miljoco Corp.
   d. Tel-Tru Manufacturing Co., Inc.
   e. Weiss Instruments, Inc.
   f. Weksler Glass Thermometer Corp.
   g. Winters Instruments.

2. **Description:** Dial type vapor or liquid actuated; ASTM E1; white with black markings and black pointer.

3. **Case:** Drawn steel, cast aluminum, or stainless steel.

4. **Size:** 4-1/2 inch diameter dial.

5. **Lens:** Clear glass.

6. **Bulb:** Copper for separable socket for liquids, averaging element for air.

7. **Scale:** Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

8. **Capillary:** Copper or bronze double-braided capillary for separable socket. Length to suit installation, minimum 5 feet.

9. **Accuracy:** Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. **Calibration:** Degrees F.

### 2.5 THERMOMETER SUPPORTS

A. **Socket:** Brass or stainless steel, separable sockets for thermometer stems with 2 inch extension for insulated piping, pressure rated to match piping system design pressure, with cap and chain.

B. **Flange:** 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.
2.6 TEST PLUGS

A. Manufacturers:
   1. Flow Design, Inc.
   2. MG Piping Products Co.
   3. Peterson Equipment Co., Inc.
   5. Watts Regulator.

B. Test Plug: 1/2 inch nickel-plated brass fitting, rated for 500 psig, extension for insulation, and threaded cap with retention chain for receiving 1/8 inch outside diameter pressure or temperature probe.

C. Core Material:
   1. Neoprene core for temperatures up to 200 degrees F.
   2. Nordel core for temperatures up to 350 degrees F.
   3. Viton core for temperatures up to 400 degrees F.

D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauge, one gauge adapter with 1/8 inch probes, two 1 inch bimetal dial thermometers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

E. Install thermometers in air duct systems on flanges.

F. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
G. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

H. Coil and conceal excess capillary on remote element instruments.

I. Provide instruments with scale ranges selected according to service with largest appropriate scale.

J. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

K. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

L. Locate test plugs adjacent thermometers and thermometer sockets.

3.2 SCHEDULE

A. Pressure Gages, Location and Scale Range:

1. Location: Install device at inlet and outlet of each of the following:
   a. Headers to central equipment.
   b. Heat exchangers.
   d. Boilers.
   e. Chillers.
   f. After major coils. Reference details on plans.
   g. Expansion tanks.
   h. Pressure reducing valves.

2. Scale Range:
   a. Vacuum: 30 inches Hg to 15 psig.
   b. All fluids: 2 times operating pressure.

B. Pressure Gage Tappings, Location:


C. Stem Type Thermometers, Location and Scale Range:
   1. Location: Install device at inlet and outlet of each of the following:
      a. Headers to central equipment.
      b. Heat exchangers.
      c. Boilers.
      d. Chillers.
      e. Hydronic zone supply and return.
      f. After major coils. Reference details on plans.
      g. Heat recovery unit
      h. Thermal storage tank.
   2. Scale Range:
      a. Hot Water: 30 to 300 degrees F with 2-degree scale divisions
      b. Condenser Water: 0 to 160 degrees F with 2-degree scale divisions.
      c. Chilled Water: 0 to 100 degrees F with 2-degree scale divisions.
      d. Steam and Condensate: 50 to 400 degrees F with 5-degree scale divisions.

D. Thermometer Sockets, Location:
   1. Control valves 1 inch & larger - inlets and outlets.
   2. Reheat coils - inlets and outlets.
   3. Cabinet heaters - inlets and outlets.
   4. Unit heaters - inlets and outlets.

E. Dial Thermometers, Location and Scale Range:
   1. Each supply air zone, minus 32 to 150 degrees F.
   2. Outside air, minus 32 to 150 degrees F.
   3. Return air, minus 32 to 150 degrees F.
   4. Mixed air, minus 32 to 150 degrees F.
SECTION 230523 - GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Applications.
   1. General duty valves common to most mechanical piping systems.
   2. Special purpose valves are specified in individual piping system specifications.

B. General requirements.

C. Globe valves.

D. Ball valves.

E. Check valves.

F. Gate valves.

1.2 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene diene monomer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. SWP: Steam working pressure.

I. TFE: Tetrafluoroethylene.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, pressure and temperature classifications, valve design, body material, seating materials, trim material, dimensions, clearances, rough-in details, weights, support requirements, and piping connections.
C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner’s name and registered with manufacturer.

D. Operation and Maintenance Data: Include manufacturer’s descriptive literature, operating instructions, maintenance and repair data, and parts listings.

E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

1.4 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from a single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
   3. Subject to compliance requirements, provide products from one of the manufacturers listed in Valve Schedule in Part 3.

B. Valves shall be certified to meet the specified ASTM, ASME, ANSI, and MSS standards in Part 2 Products, and as follows:
   1. ASME B31.9 for building services piping.
   2. ASME B31.1 for power piping.

C. Welding Materials and Procedures: Conform to .

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
b. Maintain caps in place until installation.

2. Store valves in shipping containers and maintain in place until installation.
   a. Store valves indoors in dry environment.
   
   b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
   1. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products from one of the manufacturers listed in the Valve Schedule in Part 3.

2.2 APPLICATIONS

A. Provide the following valves for the applications if not indicated on Drawings:
   1. Throttling (Hydronic): Ball, and Globe.
   2. Isolation (Hydronic): Gate, Ball, and Globe.
   3. Dead-End: Ball.

B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

C. Required Valve End Connections for Non-Wafer Types:
   1. Steel Pipe:
      a. 2 NPS and Smaller: Threaded ends.

   2. Copper Tube:
      a. 2 NPS and Smaller: Threaded or solder-joint valve ends.

      1) Exception: Solder ends not acceptable for hot water or steam pipe.

D. Chilled Water Valves:
   1. 2 NPS and Smaller:
b. Body: Bronze.

c. Allowable Valve Types:
   1) Ball: Two piece.
   2) Lift check.
   3) Swing check.
   4) Wafer plate-type check.
   5) Globe.

E. Heating Hot Water Valves:
   1. 2 NPS and Smaller:
      b. Body: Bronze.
      c. Allowable Valve Types:
         1) Ball: Two piece.
         2) Lift check.
         3) Swing check.
         4) Wafer plate-type check.
         5) Globe.

2.3 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Stem Design:
   1. Rising stem or rising outside screw and yoke stems.
   2. Non-rising stem valves may be used on water systems where headroom prevents full extension of rising stems.

D. Valve Actuator Types:
   1. Gear Actuator: Quarter-turn valves 8 NPS and larger.

E. Valves in Insulated Piping: Provide stem extensions so valve operator extends a minimum of 1/2 inches outside of the insulation and the following features:

1. Gate Valves: Rising stem.
2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:


G. General ASME Compliance:


H. Bronze Valves:

1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Source Limitations: Obtain each valve type from a single manufacturer.

2.4 BRONZE GLOBE VALVES

A. Class 125, 200 psig CWP:

1. Comply with MSS SP-80, Type 2, nonmetallic disc to metal seat.
3. Ends: Threaded or solder joint.
4. Stem and Disc: Bronze stem, PTFE disc.
5. Packing: Asbestos free, brass gland.
6. Operator: Malleable iron handwheel.
2.5 IRON GLOBE VALVES

A. Class 125, 200 psig CWP and Class 250, 500 psig CWP:
   1. Comply with MSS SP-85, Type 1.
   2. Body: Gray iron; ASTM A126, with bolted bonnet.
   3. Ends: Grooved or flanged.
   4. Trim: Bronze.
   5. Packing and Gasket: Asbestos free, two-piece backing gland assembly.
   6. Operator: Handwheel or chainwheel.

2.6 BRONZE BALL VALVES

A. Two Piece, Class 150, for valves 2 inch and smaller:
   1. Comply with MSS SP-110.
   2. CWP Rating: 600 psi.
   4. Trim: Bronze.
   5. Ends: Threaded or solder joint.
   6. Seats and Seals: PTFE.
   7. Stem: Blowout-proof.
   8. Ball: Full port, ASTM A276 Type 316 stainless steel.

2.7 BRONZE LIFT CHECK VALVES

A. Class 150:
   1. Comply with MSS SP-80, Type 2, Nonmetallic Disc to Metal Seat.
   2. CWP Rating: 200 psig.
   3. Design: Horizontal or angle pattern, capable of being refitted and ground while valve remains in the line.
   5. Ends: Threaded.
7. Disc: PTFE.

### 2.8 BRONZE SWING CHECK VALVES

**A. Class 125:**

1. Comply with MSS SP-80, Type 3.
2. CWP Rating: 200 psig.
3. Design: Horizontal swing, Y-pattern, capable of being refitted and ground while valve remains in the line.
5. Ends: Threaded or solder joint.
6. Disc: PTFE.

### 2.9 IRON, FLANGED END SWING CHECK VALVES

**A. Class 125, 200 psig CWP.**

1. Comply with MSS SP-71, Type I.
2. Design: Horizontal swing, clear or full waterway, capable of being refitted and ground while valve remains in the line.
3. Body: Cast iron with bolted bonnet in accordance with ASTM A126, Class B.
5. Trim: Bronze.
6. Disc Holder: Bronze face ring and seat ring.
7. Disc: Bronze or ductile iron.

### 2.10 IRON, WAFER PLATE-TYPE CHECK VALVES

**A. Class 125 Dual-Plate (Twin Disc):**

1. Comply with API STD 594.
2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.
3. 14 NPS to 24 NPS, CWP Rating: 150 psig.
4. Design: Wafer, non-slam, spring-loaded plates, designed to open and close at approximately 0.5 psi differential.


9. Seat: EPDM, or NBR.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. If valve is determined to be defective, replace with new valve.

3.2 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Locate valves for easy access. Provide access doors and fire rated access doors as required.

C. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

D. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

E. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.

F. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

G. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

H. Install valves in a position to allow full stem movement.

I. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
J. Valves with soldered end connections:
   1. Use solder with a melting point as follows:
      a. Below 840 degrees F for gate, globe, and check valves.
      b. Below 421 degrees F for ball valves.

K. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.
   3. Orient plate-type into horizontal or vertical position, between flanges.

L. Provide chainwheels on operators for valves 2-1/2 NPS and larger where located 72 inches or more above finished floor in mechanical rooms, terminating 60 NPS above finished floor.

3.3 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leak; replace valves if leak persists.

3.4 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

3.5 VALVE SCHEDULE

A. Bronze Globe Valves, Class 125:
<table>
<thead>
<tr>
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<th>THREADED RS</th>
<th>SOLDER RS</th>
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<td>Stockham</td>
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<td>B-14T</td>
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B. Iron Globe Valves:
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<th>CLASS 125 ANGLE BODY</th>
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<td>DG</td>
<td>--</td>
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<tr>
<td>Crane</td>
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Hammond IR116 IB463
Jenkins 2342J 2344J
Milwaukee F2981A --
Nibco F-718-B F-818-B
Powell 241 --
Stockham G-512 G-515

C. Bronze Ball Valves – 2 inch and smaller, Class 150:

1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

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<thead>
<tr>
<th>MANUFACTURER</th>
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<th>SOLDER ENDS</th>
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D. Bronze Lift Check Valves, Class 150:

Crane 27TF

E. Bronze Swing Check Valves:

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<th>MANUFACTURER</th>
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<th>CLASS 125</th>
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F. Iron Flanged End Swing Check Valves:

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G. Iron Wafer Plate-Type Check Valves:

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<td>CVOSSXXX</td>
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<td>Nibco</td>
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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

1. Horizontal piping hangers and supports.
2. Saddles and shields.
3. Anchors and fasteners.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."

E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.
   1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

F. Installer's Qualifications: Include evidence of compliance with specified requirements.

G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.4 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:
   1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
   2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
   3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
PART 2 - PRODUCTS AND MATERIALS

1.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.

2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.

3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

   a. Indoor Dry Locations: Carbon steel, galvanized steel, zinc-plated steel or approved equivalent where installed for piping and equipment that will not have a factory-applied or field-applied finish, unless otherwise indicated.

   a. Indoor Damp or Wet Locations: Galvanized steel, painted steel, Type 304 stainless steel, or aluminum.

   b. Natatorium or other treated pool environments: Aluminum.

   b. Outdoor Locations: Type 304 stainless steel, galvanized steel, aluminum, or approved equivalent.

   c. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.

   d. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

   e. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

   f. Stainless Steel: Type 304 in accordance with ASTM A240.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:
a. Cooper B-Line.
b. Ferguson Enterprises/FNW.
c. Thomas & Betts Corporation.
d. Unistrut, a brand of Atkore International Inc.
e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.

4. Channel Material:
   a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
   b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel, aluminum, or galvanized steel.
   c. All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.


7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Threaded zinc-plated steel, threaded both ends or continuously threaded, unless otherwise indicated.


3. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12”. Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Manufacturers:

1. Armacell.

3. Cooper B-Line, Inc.
4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy
6. Ferguson/FNW.
7. Halfen-DEHA.
8. Hilti.
11. Unistrut.

B. Single Hangers:
   2. Split Ring: Carbon steel, adjustable swivel, split ring type.
   3. Clevis Hanger: Carbon steel, adjustable, clevis type.

2.3 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:
   1. Manufacturers: Same as hanger and Supports.
   2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.

B. Insulation Protection Shield:
   1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.
   2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
   3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

<table>
<thead>
<tr>
<th>Pipe Size (NPS)</th>
<th>Insulation Thickness (inches)</th>
<th>Minimum Shield Length, (in)</th>
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C. 360 Degree Insulation Protection Shield:

1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

2.4 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.
2. Illinois Tool Works, Inc.
4. Powers Fasteners, Inc.
5. Rawl.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
5. Steel: Use beam clamps.


8. Plastic and lead anchors are not permitted.

9. Hammer-driven anchors and fasteners are permitted only as follows:
   a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
   b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   2. Channel Material: Use galvanized steel.
   3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
   4. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

D. Post-Installed Concrete and Masonry Expansion Anchors:
   1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
   2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
   2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.


2.5 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 23 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:
1. **Cold Piping:** Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.

2. **Hot Piping:** Provide pipe hangers sized for the pipe outside diameter.

3. **Refer to Section 230700 for definition of hot and cold piping and required insulation thickness.**

**H. Install building attachments within concrete or to structural steel.**

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

**I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.**

**J. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.**

**K. Load Distribution:** Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

**L. Pipe Slopes:** Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

**M. Insulated Piping:** Comply with the following installation requirements.

1. **Pipe Covering Protection Saddles:** Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

2. **Insulation Protection Shield:** Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation". Do not use polymer-based shields for hot piping.

   a. Exception for horizontal cold piping with fiberglass, cellular glass, flexible elastomeric, or polyisocyanurate insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.

3. **Contractor’s Option:** Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

4. **Contractor’s Option:** Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
3.4 EQUIPMENT SUPPORT AND ATTACHMENT

A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.

C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

D. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
   1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

E. Secure fasteners according to manufacturer’s recommended torque settings.

F. Remove temporary supports.

G. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.

H. Grouting: Place grout under supports for piping and equipment.

3.5 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.6 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.
B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section “Painting.”

   1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.7 PIPE HANGER AND SUPPORT SCHEDULE

A. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

B. Single Hangers:

   1. All pipe sizes 1-1/2 inch and less:
      a. Band hanger.
      b. Swivel split ring.
      c. Clevis hanger.

   2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.

   3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.

END OF SECTION
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SECTION 230550 - VIBRATION ISOLATION FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vibration isolation requirements.
B. Vibration-isolated equipment support bases.
C. Vibration isolators.

1.2 COORDINATION

A. Contractor's Responsibility:
   1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.
   2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.
   3. Coordinate selection and arrangement of vibration isolation components with the actual equipment to be installed.
   4. Coordinate the work with other trades to provide additional framing and materials required for installation.
   5. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   6. Sequencing:
      a. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

B. Manufacturer's Responsibility:
   1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.
   2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.
3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.


5. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.

6. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer’s standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.

B. Shop Drawings:

1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.


3. Piping isolators shown and identified on piping layout drawings.

4. Concrete foundations, supports, and required reinforcing and forms. These appurtenances shall be provided by another trade. This trade shall furnish the shop drawings, including the following:

   a. Concrete reinforcing steel details and templates for all foundations and supports.

   b. Required hanger bolts.

   c. All other appurtenances necessary for proper installation of equipment.

C. Vibration Isolation System Schedule: Include the following for each isolation element:

1. Manufacturer, isolator type, model number, size.

2. Height when uncompressed and static deflection.

3. Spring constant.

4. Spring outside diameter, free operating, and solid heights.

5. Design of supplementary bases.
6. Details of attachment to load-bearing structure or supplementary framing.

D. Post-Installation Inspection Report:

1. Vibration isolation vendor notice of inspection of all vibration isolators.

2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.

3. Itemized list of deficiencies.


5. For each isolator containing steel springs, record the following:
   a. Size.
   b. Uncompressed height.
   c. Design static deflection.
   d. Measured static deflection.

1.4 QUALITY ASSURANCE

A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.

B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.

C. Maintain at the project site a copy of each reference document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer’s instructions.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. BRD Noise and Vibration Control.

B. Caldyn, California Dynamics Corp.

C. Kinetics Noise Control.
D.  Mason Industries, Inc.
E.  Vibration Eliminator Co., Inc.
F.  Vibration Mounting and Controls.
G.  Vibro-Acoustics.

2.2  VIBRATION ISOLATION REQUIREMENTS

A.  Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.

B.  Select vibration isolators to provide the static deflection as specified in Part 2 “Products” unless otherwise specified for the application listed in Part 3 “Execution.”

C.  Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.

D.  Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.

E.  Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.

F.  Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

G.  Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.

H.  The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.

I.  All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.

J.  Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.

K.  Equipment mounted on vibration isolated bases shall have minimum operating clearance of 1 inch between the base and floor or support beneath unless noted otherwise.

L.  Vibration Isolator Assemblies with Steel Springs:
   1.  Housed or caged spring isolators are not acceptable.
   2.  Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.
3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.

4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.

5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.

6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.

7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection.

M. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.

1. Interior applications: Painted.

2.3 VIBRATION ISOLATORS

A. Spring and Neoprene Hanger (Type SPNH)

1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator in series with a steel spring.

   a. Housing: Include a neoprene bushing to prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function. Bottom opening sized to allow hanger rod to swing through a 30 degree arc.

2. Selection:

   a. Neoprene isolator: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.

   b. Spring isolator: Minimum static deflection of 2 inches unless specified otherwise.

3. Type SPNH: Mason Industries Type 30N or approved equal.

B. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.

C. Flexible Connectors:

1. Pipe: Refer to Section “Hydronic Piping Specialties.”

2. Duct: Refer to Section “Air Duct Accessories.”
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturer’s instructions.

B. External spring isolators are not required if unit is provided with internal spring isolation. If external spring isolators are provided, internal spring isolation will not be approved.

C. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.

D. Secure fasteners according to manufacturer’s recommended torque settings.

E. Support piping, ductwork, conduit, and mechanical equipment building structure. Do not support from other equipment, piping, or ductwork.

F. Install isolators to prevent short-circuiting of the isolation.

G. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a “U” shaped loop. Coordinate with Division 26.

H. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.

I. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.

3.3 INSTALLATION OF VIBRATION ISOLATORS

A. Neoprene Mounting Sleeves, Grommets, and Bushings: Install on vibration isolators to prevent any metal to metal contact.

B. Spring Isolators:

1. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

2. Install springs so that the ends of springs remain parallel and all springs are installed with adjustment bolts.

3. Locate isolation hangers at the top of hanger rods.

4. Type SPNH and DDNH: Install the hanger box to allow it to rotate a full 360 degrees without encountering any obstruction.
3.4 EQUIPMENT ISOLATION

A. Air Handling Units:
   1. Units that are furnished with internal structural frames and external lugs (both of suitable strength and rigidity), or without any severe overhangs, do not require an additional structural frame installed beneath the unit.
   2. Support condensate drain pipes from the isolated air handling unit frame.
   3. Suspended: Type SPNH isolation with 2 inch static deflection.

B. Inline Pumps:
   1. Supported in-line with piping: Provide vibration isolators on the piping per the article “Pipe Isolation” below.
   2. Supported independent of piping:
      a. Provide flexible connectors on each side of pump. The vertical load shall be carried by the supports, not by the flexible couplings.
      b. Suspended: Type SPNH isolation with 2 inch static deflection.

3.5 PIPING ISOLATION

A. Provide flexible connectors for piping system connections on equipment side of shutoff valves for all pumps, mechanical equipment supported or suspended by spring isolators, and where indicated on Drawings.

3.6 DUCT ISOLATION

A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

3.7 FIELD QUALITY CONTROL

A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.

B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.

C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

END OF SECTION
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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.
B. Adhesive-backed duct markers.
C. Pipe markers.
D. Engraved plastic-laminate signs.

1.2 SUBMITTALS

A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

1.3 SPARE PARTS

A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.

B. Furnish not less than 3 additional numbered valve tags for each piping system.

C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Advanced Graphic Engraving, LLC.
B. Brady Corporation.
C. Brimar Industries, Inc.
D. Craftmark.
E. Industrial Safety Supply Co., Inc.
F. Kolbi Pipe Marker Co.
G. MIFAB, Inc.
H. Seton Identification Products, a Tricor Direct Company.
2.2 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

A. General:

1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.

2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.

3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).

B. Air Handling Units: Nameplates, stencils, or engraved plastic laminate signs.

C. Air Terminal Units: stencils, or engraved plastic laminate signs.

D. Automatic Controls: use the same naming convention coordinated with the building automation system.

E. Dampers: Ceiling tacks where located above lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.

F. Ductwork: Adhesive-backed duct markers. Stencils are only acceptable for concealed ductwork, exterior ductwork, or in mechanical rooms.

G. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.

H. Piping: Pipe Markers.

I. Pumps: Nameplates or engraved plastic laminate signs.

J. Thermostats: Nameplates.

K. General Signs: Engraved plastic laminate signs.

2.3 NAMEPLATES

A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and mark number.

2. Equipment service.

3. Design capacity.
4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

   B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.


   D. Letter Height: 1/4 inch.

   E. Background Color:

      1. Cooling equipment: Green.
      2. Heating equipment: Yellow.
      3. Combination cooling and heating equipment: Yellow/Green.
      5. Hazardous equipment: Colors and designs recommended by ASME.
      6. Equipment and components that do not meet any of the above criteria: Blue.

   F. Plastic: Conform to ASTM D709.

2.4 ADHESIVE-BACKED DUCT MARKERS

   A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

   B. Style: Individual label.

   C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.

   D. Specialty Exhaust: Identify the specialty using the system terminology (e.g., Grease, Dishwasher, Dryer, Fume Hood, etc.).

   E. Color: Yellow background with black lettering or blue background with white lettering.


2.5 PIPE MARKERS

   A. Semi-rigid Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

   B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum 3 mil thick.

      1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).
C. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.

D. Nomenclature: Manufacturer’s standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.

E. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.

F. Color:
   1. Conform to .
   2. Heating, Cooling, and Boiler Feedwater: Green with white letters.

G. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.6 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, engraved with manufacturer’s standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:
   1. Name and mark number.
   2. Equipment service.
   3. Design capacity.

E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.
3.2 GENERAL INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Install products in accordance with manufacturer’s instructions.

C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Install tags on piping 3/4 inch diameter and smaller.

E. Install in clear view and align with axis of piping.

F. Apply stencil painting in accordance with Division 09.

G. Identify service, flow direction, and pressure.

3.3 PIPING IDENTIFICATION

A. General: Install identification on the most obviously visible portion of the pipe from the point of access.

B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer’s instructions.

C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe during back-filling/top-soiling of each underground piping system. Where multiple pipes are buried in common trench and do not exceed overall width of 16 inches, install single pipe marker. For tile fields and similar artificial field installations, mark only edge pipe lines of field.

D. Pipes less than 6 inches diameter (including insulation): Provide full-band pipe markers with 360 degree coverage.

E. Pipes 6 inches diameter and larger (including insulation): Provide either full-band or strip-type pipe markers.

F. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:

1. Within 5 feet of each valve, tee, and control device.

2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.

3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.

4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of equipment outlets and other points of origination and termination.

6. Spaced intermittently at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

3.4 VALVE IDENTIFICATION

A. Provide a tag on each valve, cock, and control device. Exclude check valves, valves within factory-fabricated equipment, HVAC terminal devices, and similar rough-in connections of end-use fixtures and units.

B. Mount valve tag chart and schedule frame in mechanical room, or where indicated on plans. If not indicated, mount where directed by Engineer. Where more than one mechanical room is included on the project, mount framed copies of valve tag chart and schedule in each mechanical room.

3.5 DUCTWORK IDENTIFICATION

A. Install identification on the most obviously visible portion of the duct from the point of access.

B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc), and exterior non-concealed locations as follows:

1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.

2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.

3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.

4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.

5. Within 5 feet of equipment outlets and other points of origin or termination.

6. Install marker on the most obviously visible portion of the duct from point of access.

3.6 EQUIPMENT IDENTIFICATION

A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:

1. To distinguish between multiple units in close proximity.

2. To inform operator of operational requirements.

3. To indicate safety and emergency precautions.
4. To warn of hazards and improper operations.

B. Adjust lettering size based on viewing distance from normal location of identification:
   1. Less than 2 feet: Minimum 1/4 inch.
   2. Up to 6 feet: Minimum 1/2 inch.
   3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
   4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
   5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.

C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

END OF SECTION
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SECTION 230593 TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions apply to this section.

1.2 DESCRIPTION OF WORK

A. This scope of services specifies the requirements and procedures for mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results. The test and balance work will be performed by the Owner's personnel. It is the Contractor's responsibility to assist as outlined below.

B. Test, adjust and balance the following mechanical systems which are shown in the construction documents.
   1. Supply air systems, all pressure ranges, including variable volume and constant volume systems.
   2. Return air systems.
   3. Exhaust air systems.
   4. Hydronic systems.
   5. Verify temperature control system operation.

C. The contractor’s responsibilities are as follows:
   1. Notify the Owner’s Representative fourteen (14) days prior to the schedule date for balancing the system.
   2. Schedule a five (5) week allowance for the testing and balancing firm to complete the testing and balancing work when scheduling completion of all work required of the Contractor by the contract documents.
   3. Cooperate with the testing and balancing firm and shall make all necessary preparations for the TAB efforts.
   4. Complete the following work prior to requesting the TAB effort.
      a. Clean and flush all piping systems.
      b. Leak test and make tight all piping systems.
      c. Fill all piping systems with clean water.
      d. Clean and seal all ductwork systems.
      e. Service and tag all equipment.
      f. Set and align all motors and drives.
      g. Start up and prove all equipment and systems.
      h. Make preliminary settings on all control devices and have all systems operational.
      i. Operate all systems successfully for twenty-four (24) hours minimum.
   5. Lubricate all motors and bearings.
   6. Check fan belt tension.
   7. Check fan rotation.
   8. Patch insulation, ductwork and housing, using materials identical to those removed.
   9. Seal ducts and piping, and test for and repair leaks.
  10. Seal insulation to re-establish integrity of the vapor barrier.
11. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
12. Provide a complete set of as-built drawings prior to the TAB effort.
13. Provide craftsmen of the proper trade to work with the TAB firm to make adjustments and installation changes as required.
14. Change out fan sheaves when and if required by the TAB firm.
15. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
16. If a significant rebalance (Owner's determination) of the HVAC system is required due to the Contractor's failure to properly install and check out the HVAC system, the cost of rebalancing the system shall be borne by the Contractor.

1.3 PRE-BALANCING CONFERENCE

A. Prior to beginning of the testing, adjusting and balancing procedures, a conference with the Owner's representative, Engineer and the Test and Balance Agency's representative will be held. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

1.4 SEQUENCING AND SCHEDULING OF SERVICES

A. Test, adjust and balance the air conditioning systems during summer season and heating systems during winter season. This includes at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer design condition, and within 10 deg. F dry bulb temperature of minimum winter design conditions. Take final temperature readings during seasonal operation.
SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of Mechanical insulation required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Types of Mechanical insulation specified in this Section include the following:

1. Piping Systems Insulation:
   a. Fiberglass
   b. Flexible Elastomeric

2. Ductwork System Insulation:
   a. Fiberglass

3. Equipment Insulation:
   a. Flexible Elastomeric

C. Related Sections: The following sections contain requirements that relate to this Section:


1.2 DEFINITIONS

A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.

B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.

1.3 QUALITY ASSURANCE

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

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E 84 (NFPA 255) method.
1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

C. Samples: Submit manufacturer's sample of each piping insulation type required, and of each duct and equipment insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

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

1. Aeroflex USA, Inc.
2. Armacell LLC.
3. CertainTeed Corp.
4. Johns Manville
5. Knauf Insulation
6. K-Flex USA
7. Owens Corning

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C547, Type I or II, Grade A.

B. Flexible Elastomeric Piping Insulation: ASTM C534, Type I.

C. Jackets for Piping Insulation: ASTM C1136, Type I.
1. PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, Johns Manville Zeston 2000 PVC or approved equivalent. Factory supplied, pre-cut insulation blanket inserts for use with PVC fitting covers are acceptable.

D. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

<table>
<thead>
<tr>
<th>Insulation Application</th>
<th>Insulation Permeability, Less than 4.0 perm-in. (Note 2)</th>
<th>Insulation Permeability, 4.0 or greater perm-in. (Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe and vessels (33 F to ambient)</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Ducts (40 F to ambient)</td>
<td>1.0</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.

2. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

E. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.
   a. Water-Based Mastic
      1) Permeance in accordance with ASTM C755 for insulation application and service conditions and tested in accordance ASTM E96.
         a) Pipe and vessels (33 deg. F to Ambient): 0.05 perms or less.
         b) Pipe and vessels (-40 deg. F to 32 deg. F): 0.02 perms or less.
         c) Ducts (40 degrees F to Ambient): 0.02 perms or less.
      2) Foster 30-80, Childers CP-38 or equal.
   b. Solvent-Based Mastic: Permeance shall be 0.05 perms or less at 35 mils dry per ASTM F 1249.

2. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2 or equal.
3. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

2.3 DUCTWORK INSULATION MATERIALS

Rigid Fiberglass Ductwork Insulation: UL/ULC classified, meeting ASTM C612, Types IA or IB, with density of 1.5 pounds per cubic foot.

A. Flexible Fiberglass Ductwork Insulation: UL/ULC classified, meeting ASTM C553, Type II, with density of 0.75 pounds per cubic foot.

B. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

C. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.
   a. Water-Based Mastic: Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E96. Provide Fosters 30-80, Childers CP-38 or equal.
   b. Solvent-Based Mastic: Permeance shall be 0.05 perms or less at 35 mils dry per ASTM F1249.

2. Fiberglass Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127 or equal water based adhesive.

2.4 EQUIPMENT INSULATION MATERIALS


B. Flexible Fiberglass Equipment Insulation: ASTM C553, Types IA and IB

C. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E96 or 0.08 perms at 37 mils dry per ASTM F1249. Provide Foster 30-80, Childers CP-38 or equal.

3. Fiberglass Adhesive: Comply with ASTM C916, Type II.

D. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install insulation products in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

3.2 PIPING SYSTEM INSULATION

A. General: Reference Insulation Schedules at the end of this specification for minimum insulation conductivity and thickness requirements.

B. Insulation Omitted: Omit insulation on the following:

1. Cold piping within unit cabinets provided piping is located over drain pan;
   a. Flexible Elastomeric: Insulation shall be seamless except where piping joints need to be made. Seams at piping joints shall be sealed and taped.

C. Cold Piping (40 degrees F (4.4 degrees C) to ambient):

1. Application Requirements: Insulate the following piping systems:
   a. HVAC chilled water supply and return piping.

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
   a. Flexible Elastomeric

D. Hot Non-Steam Piping (141 to 200 degrees F (61 to 94 degrees C)):

1. Application Requirements: Insulate the following piping systems.
   a. HVAC hot water supply and return piping.

2. Insulate each piping system specified above with one of the following types of insulation:
   a. Fiberglass

3.3 DUCTWORK SYSTEM INSULATION

A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork. Refer to Section “Metal Ductwork” for requirements for duct liner material.
B. Application Requirements:

1. Insulate the following duct systems:
   a. Outdoor Air.
   b. Supply Air.
      1) Insulate neck and bells of supply diffusers.

2. Insulate each ductwork system specified above with one of the following types and thickness of insulation:
   a. Rigid Fiberglass:
      1) 1" thick, minimum R-4.2.
      2) 2" thick, minimum R-8 in machine, fan and equipment rooms.
   b. Flexible Fiberglass:
      1) 1-1/2" thick, minimum R-4.2.
      2) Meet R-value installed at maximum 25% compression, application limited to concealed locations.

C. Range and hood grease exhaust ductwork: Refer to Section “Air Duct Accessories” for requirements of fire-rated wrap insulation for grease exhaust duct.

3.4 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature):

1. Application Requirements: Insulate the following cold equipment unless pre-insulated at factory:
   a. Drip pans under chilled equipment.
   b. Chilled water pumps.

2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
   a. Flexible Elastomeric: 1" thick.

3.5 INSTALLATION OF PIPING INSULATION

A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating.

E. Cold Pipe Insulation:
   1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
   2. Provide high density insulation material under supports or pre-insulated supports.
   3. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for HVAC Piping & Equipment” for pre-insulated supports and insulation shields.
   4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
   5. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

F. Hot Pipe Insulation:
   1. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Insulate pipe elbows using fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   2. Insulate tee fittings with fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   3. Insulate valves using fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   4. Insulate strainers using fiberglass inserts with pre-molded PVC parts, preformed fitting insulation, or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and
irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

5. Insulate flanges and unions using fiberglass inserts with pre-molded PVC parts or a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

6. Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Install vapor-barrier coating for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.

7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

I. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Provide PVC or metal jacket to protect insulation that is exposed in mechanical rooms and exposed below 10 feet.

a. Do not install PVC jacketing in return air plenums.
J. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

3.6 INSTALLATION OF DUCTWORK INSULATION

A. Install insulation materials with smooth and even surfaces.

B. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

C. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.

D. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

E. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed. At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.

F. Cold Ductwork in Mechanical Rooms or Other Non-Conditioned Spaces: To prevent condensation from forming on the duct supports, provide one or more of the following:

1. Install thermal break such as rigid board insulation between the support and duct.

2. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12" from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4" wide coating of vapor barrier mastic.

3. If a support device similar to unistrut is used, foam fill or stuff tube.

G. Exterior Ductwork: Install ductwork with sufficient slope to ensure that water cannot pond anywhere on the duct. Drainage must be achieved by sloping ductwork – not by varying the insulation thickness. Locate longitudinal seams of outer shell (aluminum, flexible elastomeric, or cladding as applicable) at bottom of duct. Install cladding in strict conformance with cladding manufacturer’s instructions.

H. Protect outdoor insulation from weather by installing outdoor protective weather barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified. Install protective jacket in accordance with manufacturer’s recommendations.

I. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

J. Where rectangular ducts are 24” (600mm) in width or greater, duct wrap shall be additionally secured to the bottom of the duct with mechanical fasteners, spaced on 18” (425mm) centers (maximum) to prevent sagging of insulation. Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Insulation shall be secured
to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention.

3.7 INSTALLATION OF EQUIPMENT INSULATION

A. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

B. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

C. Do not apply insulation to equipment, breechings, or stacks while hot.

D. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately. Tape all joints using a suitable, matching acrylic adhesive tape; minimum 3” wide.

E. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

F. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2”. Apply over vapor barrier where applicable. Tape all joints using a suitable, matching acrylic adhesive tape; minimum 3” wide.

G. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

H. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

I. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of Self-Adhesive Water and Weather Seal material (such as VentureClad) or jacketing, as recommended by the manufacturer.

3.8 EXISTING INSULATION REPAIR

A. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.9 PROTECTION AND REPLACEMENT

A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.

B. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed
to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

### 3.10 PIPE INSULATION SCHEDULES

#### A. ASHRAE 90.1 – 2016 Requirements, Pipe Insulation

<table>
<thead>
<tr>
<th>Fluid Operating Temp. Range (°F)</th>
<th>Insulation Conductivity</th>
<th>Nominal Pipe or Tube Size (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Conductivity, Mean Rating</strong></td>
<td><strong>&lt;1</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Btu·in./(hr·ft²·°F)</strong></td>
<td><strong>Temp., °F.</strong></td>
</tr>
<tr>
<td>Insulation Thickness, in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;350°F</td>
<td>0.32–0.34</td>
<td>250</td>
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<tr>
<td>251°F–350°F</td>
<td>0.29–0.32</td>
<td>200</td>
</tr>
<tr>
<td>201°F–250°F</td>
<td>0.27–0.30</td>
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<tr>
<td>141°F–200°F</td>
<td>0.25–0.29</td>
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<tr>
<td>105°F–140°F</td>
<td>0.22–0.28</td>
<td>100</td>
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<tr>
<td>40°F–60°F</td>
<td>0.21–0.27</td>
<td>75</td>
</tr>
<tr>
<td>&lt;40°F</td>
<td>0.20–0.26</td>
<td>50</td>
</tr>
</tbody>
</table>

**Notes:**

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: \( T = r\left((1 + t/r)^{(K/k)} - 1\right) \) where

1) \( T \) = minimum insulation thickness (in.),
2) \( r \) = actual outside radius of pipe (in.),
3) \( t \) = insulation thickness listed in this table for applicable fluid temperature and pipe size,
4) \( K \) = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
5) \( k \) = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.

c. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote a) but not to a thickness less than 1 inch.

d. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

END OF SECTION
SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section. These requirements shall be in addition to applicable Division 23 and 26 Sections.
   B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY
   A. Section includes commissioning process requirements for HVAC systems, assemblies, and equipment.

1.3 DEFINITIONS
   A. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
   B. BoD: Basis of Design: A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
   C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
   D. CxA: Commissioning Authority.
   F. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, subsystems, equipment, and components.

1.4 COMMISSIONING TEAM
   A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
   B. Members Appointed by Owner:
      1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process.
      2. Representatives of the facility user and operation and maintenance personnel.
      3. Architect and engineering design professionals.
1.5  **OWNER’S RESPONSIBILITIES**

A. Provide the OPR documentation to the CxA and each Contractor for information and use.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

C. Coordinate activities specified in paragraph below with Owner-Architect and Architect-Consultant agreements. Delete systems manual if not part of commissioning scope of work.

D. Provide the BoD documentation, prepared by Architect/Engineer and approved by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.6  **CONTRACTOR’S RESPONSIBILITIES**

A. The following responsibilities are components of the Construction Manager scope identified in other related sections. This information is highlighted here for convenience and is not a list of additional services. The only exception to the responsibilities specified elsewhere is that the CxA must be present during these operations in order to comply with the commissioning specification.

1. Attend with responsible sub-contractors commissioning progress meetings and cooperate with CxA for resolution of issues related to commissioning.

2. Integrate and coordinate commissioning process activities with construction schedule.

3. Review and authorize responsible sub-contractors to complete Pre-Functional and Functional Performance Testing (FPT) checklists provided by the CxA.

4. Authorize sub-contractors to make available technicians and/or coordinate with the manufacturer’s authorized technicians to startup HVAC systems, assemblies, and equipment and simulate conditions for the purpose of completing Functional Performance Testing.

5. Attend with responsible sub-contractors testing, adjusting, and balancing review and coordination meeting.

6. Participate with responsible sub-contractors in HVAC systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

7. Provide equipment operational and maintenance and related information requested by the CxA for final commissioning documentation.

1.7  **CXA’S RESPONSIBILITIES**

A. Provide commissioning specification to be incorporated into Contract Documents.

B. Provide Commissioning Plan for process and schedule for completing Pre-Functional checklists, manufacturer’s pre-start and startup checklists for HVACR systems, assemblies, equipment, and components to be verified and tested, and Functional Performance Testing checklists.

C. Evaluate Contract Documents (plans and specifications) prior to bidding only as the contract documents relate to the OPR and BoD documents and Commissioning Process requirements specified elsewhere. The CxA’s evaluation constitutes no responsibility over design concept, design criteria or compliance with codes. The CxA does not verify calculations, proof schematics or layouts in detail, or provide an in depth constructability review.

1. For projects pursuing LEED certification and seeking Energy and Atmosphere Credit 3 (Enhanced Commissioning), the CxA shall perform two evaluations. The first evaluation shall occur at the 50% construction document milestone and the second evaluation shall be prior to bidding.
D. Provide Pre-Functional and Functional Performance Testing commissioning forms for the contractor to complete as Work progresses (sample forms are attached at the end of this section).

E. Witness startup and simulation of conditions for equipment specified in this section. Contractor is responsible for start-up.

F. Verify that testing, adjusting, and balancing of Work is completed as required by the Contract Documents and perform limited verification of testing, adjusting, and balancing report data.


1.8 COMMISSIONING DOCUMENTATION

A. Contractors shall provide the following information to the CxA for inclusion in the Commissioning Process Final Report:
   1. Copy of contractor’s ‘as-built’ drawings indicating changes that occurred during the construction phase. The original as-built drawings are processed in accordance with requirements specified elsewhere.
   2. Copies of Plan and Documentation Requirements for Start-up and Initial Checkout.

1.9 SUBMITTALS

A. Certificates of Readiness

B. Certificates of Completion of installation, pre-start, and start-up activities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. The responsible sub-contractors shall notify the Construction Manager that the HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
   1. At the direction of the CxA, the Construction Manager and responsible sub-contractors shall participate in a teleconference prior to Functional Testing. The teleconference shall be used to verify that all HVAC systems are properly installed and functional, and are ready for functional testing. Any known problems that may impact or prevent the testing shall be discussed during the teleconference. Based on the outcome of the teleconference a date to commence testing will be determined.

B. The Controls Contractor shall notify the Construction Manager that the HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. The Construction Manager shall notify the Commissioning Authority that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
D. Set HVAC&R systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.2 TESTING AND BALANCING VERIFICATION

A. Notify the CxA at least 7 days in advance of testing and balancing work, and provide access for the CxA to witness testing and balancing work.

B. The Testing and Balancing Contractor shall make available technicians, instrumentation, and tools to assist CxA in verification of data points associated with testing and balancing of HVAC&R systems.
   1. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
   2. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. The CxA shall prepare detailed testing plans, procedures, and checklists for MEPF systems, subsystems, and equipment.

B. The responsible sub-contractors shall perform Pre-Functional and Functional Performance Testing on equipment and systems described in the Commissioning Plan.

C. The responsible sub-contractors shall provide trained technicians to perform commissioning tests and/or coordinate with equipment manufacturers to make available authorized technicians for the same purpose.

D. The CxA will witness selected tests.

E. The CxA and the responsible sub-contractor shall sign off when the Pre-functional Test Checklist forms are complete to provide notice that the equipment is ready for functional testing.

F. Tests will be performed using design conditions whenever possible.

G. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

H. The CxA may direct that set points be altered when simulating conditions is not practical.

I. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

J. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

K. If the Commissioning Plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.
L. The CxA and the Construction Manager shall sign off when the Functional Performance Testing checklist forms are complete to provide notice that the equipment is ready to turn over to the Owner.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Contractor is to provide submittals, test data, inspection record, and boiler certification to the CxA.

B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping sections. The Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

3.5 SAMPLE CHECKLISTS

A. Sample checklists are included only to provide an example of the format; they are not intended to be specific for the project. Checklists specific to the project will be provided by the CxA prior to systems and equipment testing.

B. The following key explains the Priority definitions found on the checklists:
1. Pre-Functional Test-Required prior to functional start-up and check out of equipment/system.
2. Functional Test-Required during functional testing of equipment/system.
3. Required prior to Owner demonstration/training of equipment/system.
4. Required prior to final payment for project.
5. Item requested by Owner’s Representative and to be reviewed with Owner.
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SECTION 230923 - DIRECT DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. University of Missouri Controls Specification.

B. This section contains requirements for pneumatic, electric and digital control systems as indicated on the contract drawings.

C. Contractor is responsible for providing, installing and connecting all sensors, pneumatic actuators, control valves, control dampers, electrical components and all interconnecting pneumatic tubing and electrical wiring between these devices and up to the Direct Digital Controller (DDC)

D. DDC controllers consist of Johnson Controls METASYS controllers, type NAE, DX, FEC, IOM, AHU, VAV, VMA, or UNT controllers. Owner will provide Johnson Controls METASYS controllers for the contractor to install.

E. After all equipment has been installed, wired and piped, Owner will be responsible for all termination connections at the DDC controller’s and for checking, testing, programming and start-up of the control system. Contractor must be on site at start-up to make any necessary hardware adjustments as required.

F. Once each mechanical system is completely operational under the new control system, contractor shall make any final connections and adjustments. For controls renovation jobs, contractor shall remove all unused sensors, operators, panels, wiring, tubing, conduit, etc. Owner shall have the option of retaining any removed pneumatic controls.

1.2 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Special Conditions apply to work of this section.

1.3 QUALITY ASSURANCE

A. Contractor's Qualifications:

1. Contractor shall be regularly engaged in the installation of digital control systems and equipment, of types and sizes required. Contractor shall have a minimum of five years experience installing digital control systems. Contractor shall supply sufficient and competent supervision and personnel throughout the project in accordance with General Conditions section 3.4.1 and 3.4.4.

B. Codes and Standards:

1. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.

2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for control systems.

3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.4 **SUBMITTALS**

A. Shop Drawings: Submit shop drawings for each control system, containing the following information:

B. Product data for each damper, valve, and control device.

C. Schematic flow diagrams of system showing fans, pumps, coils, dampers, valves, and control devices.

D. Label each control device with setting or adjustable range of control.

E. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

F. Provide details of faces on control panels, including controls, instruments, and labeling.

G. Include written description of sequence of operation.

H. Provide wiring diagrams of contractor provided interface and I/O panels.

I. Provide field routing of proposed network bus diagram listing all devices on bus.

**PART 2 - PRODUCTS**

**2.1 MATERIALS AND EQUIPMENT**

A. **Air Piping:**

1. Copper Tubing: Seamless copper tubing, Type M or L, ASTM B 88; wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment.

2. Flex Tubing: Virgin Polyethylene non-metallic tubing, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on polyethylene fittings. Tubing used above suspended ceilings to be plenum rated per NFPA 90A. See section 3.1.b for locations where flex tubing can be used.

3. Copper to polyethylene connections shall be compression barbed fittings or solder barbed fittings.

B. Conduit and Raceway:

1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.

2. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.

3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment.

4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.

C. Control Valves: Provide factory fabricated pneumatic or electric control valves of type, body material, and pressure class as indicated on the drawings. Butterfly style control valves are not acceptable except for two position applications. Equip control valves with heavy-duty pneumatic actuators, with proper shutoff rating for each individual application.

1. **Steam and Hot Water**
   a. Manufacturer: Do not allow KMC valves and actuators.
   b. Water Service Valves: Equal percentage characteristics.
   c. Steam Service Valves: Equal percentage characteristics.
   d. Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
2. Hydronic Chilled Water and Heating Water
   a. Hydronic control valves shall be pressure independent. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.
   b. The valve bodies shall be of cast iron, steel or bronze and rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass, or bronze.
   c. Valves shall be DeltaP Valves manufactured by Flow Control Industries, Belimo P Series, Danfoss AB-QM Series, or approved equal. Belimo EV050 Series is not acceptable.
   d. The valves shall have pressure taps across the valve for measuring the pressure drop across the valve. The pressure taps shall have ½-inch extensions for accessibility.
   e. Control valves shall be installed with unions or flanges as necessary for easy removal and replacement.
   f. Valve Tag shall include the model number, AHU being served, design flow, and maximum flow for that valve.
   g. The control valves shall be delivered preset to the scheduled design flow and should be capable of reaching 110% of the design flow to allow for field adjustment for capacity changes.

D. Control Dampers: Ruskin CD-50 or approved equal.
   1. Provide dampers with parallel blades for 2-position control.
   2. Provide opposed blades for modulating control.
   3. Dampers shall be low leakage design with blade and edge seals.
   4. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.

E. Electric Actuators: Johnson Controls, Bray, Belimo, TAC or approved equal. KMC actuators are not approved. Size electric actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. If mixed air AHU has return air, exhaust air and outside air dampers that are not mechanically linked then static safety switch must be installed and wired to safety circuit. Spring return actuators should be provided on heat exchanger control valves or dampers or as specified on the drawings. Control signal shall be 0 to 10 VDC unless otherwise specified on drawings. Actuators with integral damper end switch are acceptable. For VAV reheat valves, actuators shall have a manual override capability to aid in system flushing, startup, and balancing.

F. Air and Hot Water Electronic Temperature Sensors:
   1. All electronic temperature sensors shall be compatible with Johnson METASYS systems.
   2. Sensors shall be 1,000 ohm platinum, resistance temperature detectors (RTDs) with two wire connections. Duct mounted sensors shall be averaging type. Contractor may install probe type when field conditions prohibit averaging type, but must receive permission from Owner’s Representative.
   3. Coordinate thermowell manufacturer with RTD manufacturer. Thermowells that are installed by the contractor, but are to have the RTD installed by owner, must be Johnson Controls Inc. series WZ-1000.

G. Electronic Temperature Sensors and Transmitters:
a. General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Tower/Hot Water and steam temperatures in a mechanical room environment.

b. Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. Results are to be programmed into the transmitter. Results are to be presented on report as after condition at the specified calibration points. Assembly shall not be approved for installation until Owner has received all factory calibration reports.

c. RTD:
1) RTD type: 2-wire or 3-wire 100 ohm platinum class A
2) Outside Diameter: 0.25 inch
3) Tolerance: +/- 0.06% Type A
4) Stability: +/- 0.1 % over one year.
5) TCR: 0.00385 (ohm/ohm/°C).
6) RTD shall be tip sensitive.
7) Resistance vs. Temperature table for the RTD must be provided to the Owner.

d. Transmitter:
1) Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
2) Type: 2 wire (loop powered)
3) Input: 2 or 3 wire 100 ohm platinum class A or class B RTD
4) Output: Output shall be a 4-20 mA signal linear to temperature
5) Calibrated Span:
   a) Chilled Water: 30 °F to 130 °F.
   b) Tower Water: 30 °F to 130 °F.
   c) Hot Water: 100 °F to 250 °F.
   d) Steam: 150 °F to 450 °F
6) Calibration Accuracy, including total of all errors, of the Transmitter & RTD matched pair over the entire span shall be within +/- 0.2% of the calibrated span or +/- 0.18 °F, whichever is greater.
7) Supply Voltage: 24 VDC.
8) Ambient Operating Temp.: 32 to 122 °F
9) Epoxy potted for moisture resistance.
10) Mounting: Transmitter shall be mounted in the RTD connection head.

e. Thermowell
1) Thermowell shall be suitable for immersion in chilled/hot water and steam.
2) Thermowell shall be reduced tip.
3) Thermowell shall be one piece stainless steel machined from solid bar stock.
4) Thermowell shall have 1/2” NPT process connection to pipe thred-o-let.
5) Thermowell Insertion depth shall be ½ the inside pipe diameter but not to exceed 10”.

f. Assembly:
1) Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.
2) Connection head shall be cast aluminum with chain connecting cap to body, have 1/2” NPT process and 3/4” NPT conduit connections, and a sealing gasket between cap and body.

g. RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:
1) Manufacturer: Pyromation, Inc.
2) Chilled Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(30-130)F with calibration SMC(40,60)F
3) Hot Water: RAF185L-S4C[length code]08T2-SL-8HN31, TT440-385U-S(100-250)F with calibration SMC(140,180)F

H. Occupant Override: Provide wall mounted occupant override button in locations shown on drawings.

I. Low Limit Controllers: Provide unit-mounted low limit controllers, of rod-and-tube type, with an adjustable set point and a manual reset. Capillary shall be of adequate length to horizontally traverse face of cooling coil every 12”. Multiple low limit controllers may be required for large coils. Controller shall have an extra set of contactors for connection to control panel for alarm status. Locate the thermostat case and bellows where the ambient temperature is always warmer than the set point.
   1. Freeze Stats: Johnson Controls model A70HA-1 or approved equal.

J. Humidistats: Humidistats must be contamination resistant, capable of ±2% RH accuracy, have field adjustable calibration and provide a linear proportional signal.
   1. HD20K-T91 or equivalent.

K. Humidity High Limit
   1. Multi-function device that can function as a high limit or proportional override humidity controller, as stand-alone proportional controller, or a stand-alone two-position controller.
      a. Johnson Controls TRUERH HL-67N5-8N00P or approved equal.

L. Carbon Dioxide Sensor:
   1. Wall Mount: ACI Model ESENSE-R.
   2. Duct Mount: ACI Model ESENSE-D.

M. Fan/Pump Status: Status points for fan or pump motors with a VFD must be connected to the terminal strip of the VFD for status indication.

N. Current switches: Current switches are required for fan and pump statuses that are not connected to a VFD. The switches must have an adjustable trip setpoint with LED indication and be capable of detecting broken belts or couplings. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty.
   1. Kele, Hawkeye or approved equal.

O. Relays Used for Fan and Pump Start/Stop: Must have LED indication and be mounted externally of starter enclosure or VFD.
   1. Kele, RIBU1C or approved equal.

P. Power Supply Used to Provide Power to Contractor-Provided Control Devices: Shall have adjustable DC output, screw terminals, overload protection and 24 VAC and 24 VDC output.
   1. Kele, DCPA-1.2 or approved equal.

Q. Pressure Differential Switch:
   1. Fans: NECC model DP222 or approved equal.

R. Differential Pressure Transmitter: Provide units with linear analog 4-20mA output proportional to differential pressure, compatible with the Johnson METASYS Systems.
   1. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of +/- 50 psid. Accuracy shall be +/- 0.25% full scale with a compensated temperature range of 30 to 150 deg F and a maximum working pressure of 250 psig. Install transmitter in a pre-manufactured bypass valve assembly with shut-off valves, vent valves and a bypass valve, all enclosed in a NEMA 1 enclosure.
      a. Setra model 230 with Kele model BVA-5 bypass valve assembly, or approved equal.
   2. Air: Units shall be capable of measuring a differential pressure of 0 to 5 in. WC. Accuracy shall be +/- 1.0% full scale with a compensated temperature range of 40 to 149 deg F and a maximum working pressure of 250 psig.
a. Setra model 267, or approved equal.
b. Shall be installed in control panel and piped 2/3 down the duct unless shown otherwise or approved by owners representative.

S. AIRFLOW/TEMPERATURE MEASUREMENT DEVICES
1. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
2. The measurement device shall consist of one or more sensor probe assemblies and a single, remotely mounted, microprocessor-based transmitter. Each sensor probe assembly shall contain one or more independently wired sensor housings. The airflow and temperature readings calculated for each sensor housing shall be equally weighted and averaged by the transmitter prior to output. Pitot tubes and arrays are not acceptable. Vortex shedding flow meters are not acceptable.
3. All Sensor Probe Assemblies
   a. Each sensor housing shall be manufactured of a U.L. listed engineered thermoplastic.
   b. Each sensor housing shall utilize two hermetically sealed, bead-in-glass thermistor probes to determine airflow rate and ambient temperature. Devices that use "chip" or diode case type thermistors are unacceptable. Devices that do not have 2 thermistors in each sensor housing are not acceptable.
   c. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/-2% of reading over the entire operating airflow range. Each sensor housing shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
      1) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
   d. The operating temperature range for the sensor probe assembly shall be -20°F to 160°F. The operating humidity range for the sensor probe assembly shall be 0-99% RH (non-condensing).
   e. Each temperature sensor shall be calibrated at a minimum of 3 temperatures and have an accuracy of +/-0.15°F over the entire operating temperature range. Each temperature sensor shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
   f. Each sensor probe assembly shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
   g. Each sensor assembly shall not require matching to the transmitter in the field.
   h. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.
4. Duct and Plenum Sensor Probe Assemblies
   a. Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly. Thermistor probes shall be mounted in sensor housings using a waterproof marine grade epoxy resin. All wires within the aluminum tube shall be Kynar coated.
   b. The number of sensor housings provided for each location shall be as follows:
      1) Area (sq.ft.)   Sensors
         <2            4
         2 to <4       6
         4 to <8       8
         8 to <16      12
         >=16          16
c. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
1) Insertion mounted through the side or top of the duct.
2) Internally mounted inside the duct or plenum.
3) Standoff mounted inside the plenum.
d. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5. Transmitters
a. The transmitter shall have a 16 character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics. Configuration settings and diagnostics shall be accessed through a pushbutton interface on the main circuit board. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.
b. The transmitter shall be capable of independently monitoring and averaging up to 16 individual airflow and temperature readings. The transmitter shall be capable of displaying the airflow and temperature readings of individual sensors on the LCD display.
c. The transmitter shall have a power switch and operate on 24 VAC (isolation not required). The transmitter shall use a switching power supply fused and protected from transients and power surges.
d. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
e. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
f. The transmitter shall be capable of communicating with the host controls using one of the following interface options:
   1) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire).
   2) RS-485: Field selectable BACnet-MS/TP, ModBus-RTU and Johnson Controls N2 Bus.
   3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, ModBus-TCP and TCP/IP.
g. LonWorks Free Topology.

6. The transmitter shall have an infra-red interface capable of downloading individual sensor airflow and temperature data or uploading transmitter configuration data to a handheld PDA (Palm or Microsoft Pocket PC operating systems).

7. The measuring device shall be UL listed as an entire assembly.

8. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

9. Manufacturer
   a. Primary flow elements, sensors, meters and transducers shall be EBTRON, Inc. Model GTx116-P and GTx116-F or approved equal.
   b. The naming of any manufacturer does not automatically constitute acceptance of this standard product nor waive their responsibility to comply totally with all requirements of the proceeding specification.

T. Electrical Requirements: Provide electric-pneumatic switches, electrical devices, and relays that are UL-listed and of type which meet current and voltage characteristics of the project. All devices shall be of industrial/commercial grade or better. Residential types will be rejected.

1. EP Switches: Landis & Gyr Powers, Inc. Series 265 - Junction Box Type or approved equal.
2. Relays: Relays shall have an LED status indicator, voltage transient suppression, Closed-Open-Auto switch, plastic enclosure, and color coded wires. Kele model RIBU1C or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer’s instructions, roughing-in drawings and details shown on drawings.

B. Raceway: Raceway is to be installed in accordance with the National Electric Code. Use of flexible metal conduit or liquidtight flexible conduit is limited to 36” to connect from EMT to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.

C. Control Wiring: Install control wiring in raceway, without splices between terminal points, color-coded. Install in a neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
   1. Install circuits over 25-volt with color-coded No. 12 stranded wire.
   2. Install electronic circuits and circuits under 25-volts with color-coded No. 18 stranded twisted shielded pair type conductor.
   3. N2 communications bus wire shall be 18 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 18-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.
      a. Metastat wiring shall be minimum 20 AWG, plenum rated, stranded, 8 conductor stranded wire.
   2. FC communications bus wire shall be 22 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 22-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.
      a. Network sensor wiring (SA Bus) shall be 22 gauge plenum rated stranded twisted wire, 4 conductor.
   3. All control wiring at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel. Label all control wires per bid documents.

D. All low voltage electrical wiring shall be run as follows:
   1. Route electrical wiring in concealed spaces and mechanical rooms whenever possible.
   2. Provide EMT conduit and fittings in mechanical rooms and where indicated on drawings.
   3. Low voltage electrical wiring routed above acoustical ceiling is not required to be in conduit, but wire must be plenum rated and properly supported to building structure.
   4. Provide surface raceway, fittings and boxes in finished areas where wiring cannot be run in concealed spaces. Route on ceiling or along walls as close to ceiling as possible. Run raceway parallel to walls. Diagonal runs are not permitted. Paint raceway and fittings to match existing conditions. Patch/repair/paint any exposed wall penetrations to match existing conditions.

E. All devices shall be mounted appropriately for the intended service and location.
   1. Adjustable thermostats shall be provided with base and covers in occupied areas and mounted 48” above finished floor to the top of the device. Tubing and/or wiring shall be concealed within the wall up to the ceiling where ever possible. Surface raceway may only be used with approval of Owners Representative. Wall mounted sensors such as CO2, RH, and non-adjustable temperature sensors shall be mounted 54” above finished floor.
Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.

2. All control devices shall be tagged and labeled for future identification and servicing of control system.

3. Preheat and mixed air discharge sensors must be of adequate length and installed with capillary tube horizontally traversing face of coil, covering entire coil every 24 inches bottom to top.

4. All field devices must be accessible or access panels must be installed.

F. Install magnehelic pressure gage across each air handling unit filter bank. If the air handling unit has a prefilter and a final filter, two magnehelic pressure gages are required.

3.2 ADJUSTING AND START-UP

A. Start-Up: Temporary control of Air Handling Units shall be allowed only if approved by the owner’s representative to protect finishes, etc., AHUs may be run using caution with temporary controls installed by contractor early in the startup process. All safeties including a smoke detector for shut down must be operational. Some means of discharge air control shall be utilized and provided by the contractor such as a temporary temperature sensor and controller located and installed by the Contractor.

B. The start-up, testing, and adjusting of pneumatic and digital control systems will be conducted by owner. Once all items are completed by the Contractor for each system, Contractor shall allow time in the construction schedule for owner to complete commissioning of controls before project substantial completion. This task should be included in the original schedule and updated to include the allotted time necessary to complete it. As a minimum, the following items are required to be completed by the Contractor for Owner to begin controls commissioning.

1. Process Control Network
   a. The control boards and enclosures need to be installed in the mechanical rooms.
   b. The fiber optic conduit and box for the process control network needs to be installed. Once in place, Owner needs to be contacted so the length of the owner provided fiber cable can be determined and ordered, if required. Coordinate with Owner to schedule the pull in and termination of the fiber cable. Power should be in place at that time. (Fiber for the process control network is required to allow metering of utilities prior to turn on.)

2. Heating System
   a. Pumps, heat exchangers, steam pressure reducing station, piping, control valves, steam and/or hot water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, steam regulators set to required pressure, condensate pumps operational, heating system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.

3. Cooling System
   a. Pumps, heat exchangers, piping, control valves, chilled water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, cooling system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.

4. VAVs-First Pass
a. Power, (FC or N2 bus), and control wire installed before owner can make first commissioning pass. First pass includes installation of VAV controller, termination of power, control and network communication wiring.

5. Air Handlers
   a. Prior to owner commissioning, at a minimum, the following items shall be complete:
      Power wiring, motor rotation check, fire/smoke dampers open, control wiring including all safeties, IO cabinet, air handler cleaned, and filters installed as required.
      To protect the systems from dirt, outside air with no return will be used until the building is clean enough for return air operation.

6. VAVs-Second Pass
   a. After the air handlers are running and under static pressure control and the heating water system is operating, a second pass can be made on the VAVs to download the control program and commission controllers to verify the VAV dampers, thermostat, and reheat control valves are working properly.

7. Some balance work can be done alongside the control work as long as areas are mostly complete and all diffusers are in place.

3.3 CLOSEOUT PROCEDURES

   A. Contractor shall provide complete diagrams of the control system including flow diagrams with each control device labeled, a diagram showing the termination connections, and an explanation of the control sequence. The diagram and sequence shall be framed and protected by glass and mounted next to controller.

   B. Contractor shall provide as built diagram of network bus routing listing all devices on bus, once wiring is complete prior to scope completion.

END OF SECTION
SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes piping systems for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Piping materials and equipment specified in this Section include:

1. Pipes

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 2 Section "Earthwork," for trenching and backfilling materials and methods for underground piping installations.

2. Division 3 “Concrete” for concrete, reinforcement and formwork for concrete equipment pads.

3. Division 7 Section "Penetration Firestopping," for materials and methods for fire barrier penetrations.

4. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.


6. Division 23 Section "Common Work Results for HVAC" for materials and methods for wall and floor penetrations and equipment pads.

7. Division 23 Section "Basic Piping Material and Methods," for materials and methods for dielectric fittings, and mechanical sleeve seals.


1.2 SYSTEM DESCRIPTION

A. General: The hydronic piping systems are the "water-side" of an air-and-water or all-water heating and air conditioning system. Hydronic piping systems specified in this Section include 2- or 4-pipe, hot water and chilled water piping system, and condenser water piping system. These systems are classified by ASHRAE as Low Water Temperature, Forced, Recirculating systems.

B. 4-Pipe System: The 4-pipe system includes independent chilled water and hot water supply and return piping mains in a closed loop, connecting the boilers and chillers to the terminal heat transfer units by means of primary/secondary piping loops. Circulation is accomplished by constant or variable volume, primary and/or secondary pumps in parallel or series configuration. Design flow rates and water temperatures are specified in the various equipment specifications and schedules. Control sequences and temperature reset schedules are specified in the temperature control specifications.

1.3 SUBMITTALS

A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.

B. Submit a schedule of proposed materials for each hydronic system. Include the following:

1. Application (e.g., Chilled Water, Hot Water, etc.).
2. Location (e.g., above grade, below grade).
3. Pipe size range.
4. Materials corresponding to the pipe size range.
5. Connection methods (e.g., threaded, flanged, grooved, welded, etc.).

C. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.

D. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe and fittings.

E. Reports specified in Part 3 of this Section.

F. Coordination Drawings:

1. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   a. Suspended ceiling components.
   b. Other building services.
   c. Structural members.

G. Record Drawings:
1. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.

2. One complete set of drawings in electronic AutoCAD and pdf format.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: comply with the provisions of the following:
   1. ASME B 31.9 "Building Services Piping" for materials, products, and installation.
   2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

B. Pipe and pipe fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.5 COORDINATION

A. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.

B. Copper Tubing:
   1. Drawn Temper Tubing: ASTM B88, Type L.

C. Steel Pipe:
   1. NPS 2 and Smaller: ASTM A 53, Type E (electric resistance welded) or Type S (seamless), Grade B, Schedule 40, black steel, plain ends.

2.2 FITTINGS

A. Cast-Iron Fittings:


C. Steel Fittings:
   1. General: ASTM A 234, seamless or welded, for welded joints.
2. Flanges and Flanged Fittings: ANSI B16.5, Class 150 for low pressure service and Class 300 for high pressure service, including bolts, nuts, and gaskets of the following material group, end connection and facing:
   b. End Connections: Butt Welding.
   c. Facings: Raised face.

D. Wrought Copper Fittings:

E. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.

F. Unions: ANSI B16.39 malleable-iron, Class 150 for low pressure service and Class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.

G. Dielectric Unions, Waterway Fittings and Flanges: As specified in Division 23 “Basic Piping Materials and Methods.”

2.3 JOINING MATERIALS
   A. Reference Section “Basic Piping Materials and Methods” for basic joining materials.
   B. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony.
   C. Brazing Filler Metals:
      1. AWS A5.8, Classification BAg–5.
         a. Silver (Ag) 44.0 – 46.0%
            1) WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

2.4 VALVES
   A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 23 Section “General-Duty Valves for HVAC Piping.” Special duty valves are specified in Division 23 Section “Hydronic Specialties.”

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL
   A. Install products in accordance with manufacturer’s instructions.
3.2 PIPE APPLICATIONS

A. Install Type L copper tubing with wrought copper fittings and solder joints for 2 inch and smaller, above ground, within building.

B. Install steel pipe with threaded joints and fittings for 2 inch and smaller.

3.3 PIPING INSTALLATIONS

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 times the pipe diameter may be used only where space does not permit the long radius elbows.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

H. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Common Work Results for HVAC" for special sealers and materials.

I. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

J. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

K. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.

1. Tee-drilling is prohibited as a means for connecting branch taps into any main.
L. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.

M. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

N. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

O. Install flexible connectors at inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment. Omit flexible connectors if replaced by series of three grooved couplings on projects where grooved pipe is used.

P. Install strainers on the supply side of each pressure reducing valve, pressure regulating valve, pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

Q. Anchor piping to ensure proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors devices are specified in Division 23 Section "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT." Conform to the table below for maximum spacing of supports:

1. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.

2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

3. Pipe roller complete - MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.

4. Spring hangers to support vertical runs.

5. Provide insulation saddles and protection shields as specified in Section “Hangers & Supports for HVAC Piping & Equipment”. Provide insulation inserts as specified in Section “HVAC Insulation”.

C. Install hangers with the following minimum rod sizes and maximum spacing:

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2-1/2 11 9 1/2  
3 12 10 1/2  
4 14 12 5/8 (1/2 for copper)

D. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.

E. Install a support within one foot of each change of direction.

F. Space supports not more than five feet apart at valves, strainers or piping accessories in piping larger than 2”.

3.5 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS “Soldering Manual.”

B. Brazed Joints: Comply with the procedures contained in the AWS “Brazing Manual.”

1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

2. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.

3. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.

4. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.

5. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.


C. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. Welded Joints: Comply with the requirement in ASME Code B31.9-“Building Services Piping.”

E. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.6 VALVE APPLICATIONS

A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:


2. Throttling duty: use globe, ball, and butterfly valves.

3. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

4. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.

B. Special Duty Valve Applications: Special duty valve applications are specified in Division 23 Section “Hydronic Specialties”.

3.7 FIELD QUALITY CONTROL

A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:

1. Leave joints including welds uninsulated and exposed for examination during the test.

2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.

3. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

4. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

B. Pressure Testing: Test hydronic piping as follows:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system. Use drains installed at low points for complete removal of the liquid.

3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.

4. Subject piping systems other than ground source heat pump loop systems to a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the “SE” value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

6. Provide test reports summarizing the test procedures and results of the tests.

C. Flushing:

1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.

2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.

3. Isolate new pipe from existing pipe during flushing.

4. Provide temporary valves, connections, and bypasses where required.

5. System pumps may be used for flushing. Where system pumps are not used, provide temporary pumps with temporary connections.

6. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.

7. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.

8. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

D. Fluid Testing: After filling the system as described under Paragraph “Startup”, perform the following fluid test procedures:
1. Circulate the fluid for a minimum of 24 hours with all pumps operating and with shutoff valves and control valves in wide open position to ensure thorough mixing of the antifreeze or glycol solution throughout the system.

2. Remove fluid from a minimum of three different locations and test fluid samples at an independent testing agency for percentage of antifreeze or glycol. Coordinate with the testing agency for amount of sample needed for proper testing.

3. If any sample does not meet the specified percentages, remove sufficient fluid from the system, add antifreeze or glycol as required to achieve the specified percentage and repeat the circulation and testing procedures specified above.

4. After the samples meet the specified percentages, submit to the Owner and Engineer signed and dated test report(s) from independent testing agency that document the location of the sample and the results of the fluid test.

5. One month prior to end of the warranty period, Contractor shall submit samples to an independent testing agency to test the fluid for percentage of antifreeze or glycol. If the test samples have the specified percentage, submit copies of the test reports to the Owner and Engineer as described above in Paragraph 4. If any sample does not meet the specified percentage, Contractor shall perform the work described above in Paragraphs 3 and 4.

3.8 ADJUSTING AND CLEANING

A. Cleaning Agent Concentration:

1. As recommended by manufacturer.

B. Hot Water Heating Systems:

1. Apply heat while circulating, slowly raising temperature to 160 F and maintain for 12 hours minimum.

2. Remove heat and circulate to 100 F or less, drain systems as quickly as possible.

3. Refill with clean water and repeat until system cleaner is removed.

C. Chilled Water and Closed Loop Condenser Water Systems:

1. Circulate for 48 hours, then drain systems as quickly as possible.

2. Refill with clean water, circulate for 24 hours, then drain.

3. Refill with clean water and repeat until system cleaner is removed.

D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.

E. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.
F. Remove and clean or replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

H. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

I. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

3.9 STARTUP

A. Fill system and perform initial chemical treatment. For systems with antifreeze or glycol, fill systems with specified percentages.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:
   1. Open valves to full open position. Close coil bypass valves.
   2. Remove and clean strainers.
   3. Check pump for proper direction of correct improper wiring.
   4. Set automatic fill valves for required system pressure.
   5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
   6. Set temperature controls so all coils are calling for full flow.
   7. Check operation of automatic bypass valves.
   8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
   9. Lubricate motors and bearings.

END OF SECTION
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SECTION 232114 - MECHANICALLY JOINED HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section applies to the following mechanically-joined mechanical piping systems as defined in Division 23 Section “Hydronic Piping.” These are the only systems approved for use with mechanical fittings. Fire protection and domestic water piping are specified in other divisions.

1. Two-pipe chilled water system.
2. Two-pipe hot water system.

B. The Division 23 contractor may provide mechanically joined couplings, fittings, valves and related components as an option in lieu of, in whole or in part, welded, threaded or flanged piping methods.

C. All press-to-connect product components shall be of one manufacturer.

1.2 SECTION INCLUDES

A. Copper grooved piping system.

1.3 RELATED SECTIONS

A. Division 23 Section "Common Work Results for HVAC" for general materials and installation requirements.

B. Division 23 Section "Basic Piping Materials and Methods" for general piping materials and installation requirements and dielectric fittings.

C. Division 23 Section "General Duty Valves for HVAC Piping."

D. Division 23 Section "Hydronic Piping" for piping systems for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping.

E. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.

F. Division 23 Section "Meters and Gauges for HVAC Piping" for thermometers, flow meters, and pressure gauges.

G. Division 23 Section "Identification for HVAC Piping and Equipment" for labeling and identifying hydronic piping.

H. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
1.4 SUBMITTALS

A. Product Data: Submit data for each type of coupling, fitting, and special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing.

B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.

   1. If an assembly of flexible couplings are used for seismic vibration, thermal expansion, or noise and vibration reduction, submit shop drawings indicating location of assembly, including anchors and guides. Include movement analysis of the assembly, and performance data of the assembly.

C. Maintenance Data: Include for each hydronic specialty and special-duty valve in maintenance manuals specified in Division 01 and Division 23 Section “General Mechanical Requirements.”

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

E. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

F. Submit a schedule of dissimilar metal joints and adaptor flanges and flange kits. Include joint type material, connection method and proposed flange kits to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Dielectric flange kits are specified in Division 23 Section “Basic Piping Materials and Methods”.

G. Submit certification that pipe, pipe fittings, pipe specialties, and valves and fittings are manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

1.5 QUALITY ASSURANCE

A. Obtain training from the press-fit system manufacturer for all workers that will be installing or handling the grooved or press-fit piping systems.

B. Pipe, fittings, and specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.6 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.
C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for fire stopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. This specification references Victaulic model numbers as examples of product design intent. Manufacturers listed below may have comparable products which comply with the component specifications. Refer to manufacturer’s current literature for comparable products and pressure ratings of couplings and standard fittings for various pipe sizes and pipe schedules. Products identified by model number are based on available size ranges from that manufacturer. Products offered by manufacturers with extended ranges are acceptable provided they meet the specified requirements.

B. Copper Press to Connect Piping System:
   1. Anvil International “Gruvlok.”
   2. Apollo “Xpress”.
   4. Viega, ProPress.

2.2 COPPER PRESS FIT PIPING SYSTEM (CTS)

A. This section references Nibco model numbers for product design purposes.

B. Pipe:
   1. CTS 3/4 inch through 4 inch: ASTM B88 Type L.

C. General requirements for couplings, adapters, and standard fittings:
   1. Acceptable body materials:
      a. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.
      b. Cast copper conforming to ASTM B584 alloy C87600 or C84400.
   2. Coupling and fitting housings with soldered ends shall conform to ASME B16.18 and B16.22.
4. Coupling and fitting housings with threaded ends shall conform to ASME B1.20.1.

5. Coupling and fitting housings for press ends shall have self-contained O-ring seals in the coupling/fitting ends.

D. O-Ring Seals: EPDM compound conforming to ASME B16.51, style suitable for the application.

E. Flange Adapters:
   1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).
   2. 2-1/2 inch through 4 inch (ANSI class 125/150):
      a. Copper or brass press to connect joint with copper face ring and plastic or rubber dielectric isolating ring separating the flange from the press to connect joint.

F. Valves:
   1. Ball Valve:
      a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-110.
      b. Body and trim: Cast bronze conforming to ASTM B62 or B584.
      c. Ends: Female press to connect ends of copper or brass material.
      d. Stem: Blow-out proof, of material silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel.
      e. Seat: PTFE or TFE, suitable for intended service.
      f. Operator: Lever handle with non-thermal conductive material for insulated piping. Provide with 2 inch extended sleeve to allow valve operation without disturbing the insulation and with memory stop for throttling, metering or balancing service.
      g. 3/4 inch through 2 inch: NIBCO PC585-70-66 series.
   2. Gate Valves:
      a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
      b. Body and trim: Cast bronze conforming to ASTM B62 or B584 with threaded bonnet and solid wedge.
      c. Ends: Female press to connect ends of copper or brass material.
      d. Stem: Silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel, rising type with brass packing gland and non-asbestos composition packing.
      e. Operator: Malleable or ductile iron hand-wheel.
f. 3/4 inch through 2 inch: NIBCO PF111.

3. Globe Valves:
   a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
   b. Body and trim: Cast bronze conforming to ASTM B62 or B584 with threaded bonnet.
   c. Disc: PTFE renewable seat and disc.
   d. Ends: Female press to connect ends of copper or brass material.
   e. Stem: Silicon bronze conforming to ASTM B99, or stainless steel, rising type with brass packing gland and non-asbestos composition packing.
   f. Operator: Malleable or ductile iron hand-wheel.
   g. 3/4 inch through 2 inch: NIBCO PF211.

4. Check Valves (Y Pattern, Swing Type, or In-line):
   a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
   b. Body and trim: Cast bronze conforming to ASTM B62.
   c. Disc: PTFE renewable seat and disc.
   d. Ends: Female press to connect ends of copper or brass material.
   e. NIBCO PF413 or PF480.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

A. Provide Hydronic Piping Systems from one or more of the following mechanically joined piping system types.

   1. Hot Water system
      a. Press Fit Copper (CTS) [3/4 inch through 2 inch].

   2. Chilled Water system
      a. Press Fit Copper (CTS) [3/4 inch through 2 inch].

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Hydronic piping installations shall be installed subject to Division 23 Section “Hydronic Piping” in addition to those requirements specified in this Section.

C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

3.3 HANGERS AND SUPPORTS

A. Support of piping must account for expansion and contraction, vibration, and the dead load of the piping and its contents.

B. General: Hanger, supports, and anchors devices are specified in Division 23 Section "Supports and Anchors". Reference Division 23 Section "Hydronic Piping" for pipe spacing limitations.

3.4 PIPE JOINT CONSTRUCTION

A. Press to Connect System:

1. Install press piping system in accordance with manufacturer’s recommendations.

2. Ream, debur and clean tube ends and verify they are free from indentations, projections, burrs and foreign matter.

3. Install permanent inspection mark on tube.

4. Clean tube and fittings of all dirt and oil. Verify O-ring is in place and free of oil, grease or dirt.

5. Push copper tube into fittings with twisting action to all the way to the fitting stop or shoulder.

6. Mark tube with permanent marker to indicate proper tube insertion depth.

7. Verify press tool has correct size jaw set for tube size used.

8. Complete one tool cycle with empty jaw to calibrate tool for each time new jaw is inserted into tool.

9. Squeeze jaw arms to open tool jaws and place jaws around the contour of the fitting. Verify tool is perpendicular to the fitting and depress tool switch.

10. Squeeze jaw open to remove the tool and observe witness mark.

11. Verify crimped fitting connection for misalignment of the copper tube, misalignment of the tool or improper insertion of the tube. If any of these conditions are found cut out the joint and provide a new joint.

12. Maintain minimum distance between joints per the manufacturer’s published installation instructions.
B. Dielectric Isolation Requirements: Refer to Division 23 Section “Basic Piping Materials and Methods” for dielectric fittings and their installation requirements. Provide dielectric flanges, flange kits, or dielectric transition couplings for the following joint types:

1. Flange Adapters to Iron, Ductile Iron or Steel Body Valves or Fittings (Except Butterfly Valves): Provide full face gaskets between flanges and adapter flanges. At each bolt, provide steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on valve and adapter flanges.

2. Flange Adapters to Butterfly Valves in Series with Iron, Ductile Iron or Steel Body Valves or Fittings: At each bolt, provide stainless steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on adapter flange. Provide stainless steel bolts on butterfly valve flange.

3. Flange Adapters to Butterfly Valves in Copper Tubing: Install flat washers at each bolt on adapter flange. Provide full face gasket only for butterfly valves without integral liner acting as a gasket.

4. Dielectric Transition Couplings: Provide dielectric transition coupling when connecting copper pipe to butterfly valves. Provide dielectric transition coupling when connecting grooved IPS pipe to CTS pipe.

C. Couplings:

1. Install high pressure rigid couplings for high pressure service applications. Confirm with the coupling manufacturer the coupling style required.

2. Install flexible couplings where system flexibility is required. Examples include flexible couplings at pumps and expansion joints.

3. Install three flexible couplings at mechanical equipment connections for noise and vibration reduction in lieu of flexible connectors if preferred.

D. Flange Adapters:

1. Install flange adapter washers when flange adapters are used against the following surfaces:
   a. Rubber.
   b. Adapting to ANSI/AWWA cast flanges.
   c. Rubber faced lug valves.
   d. Serrated flanged surfaces.

2. Do not install flange adapters for applications that incorporate tie rods for anchoring or on standard grooved-end fittings within 90 degrees of each other.

E. Miscellaneous Connections:
1. Install test caps for temporary use during piping system testing activities. Test caps shall not be permanently installed in the piping system.

2. Test caps may be reused within the maximum test pressure and provided the product remains undamaged. Inspect and verify the suitability for service of all test caps prior to installation and use.

3. Connect test caps to piping system with Victaulic Style 107N or equivalent rigid coupling.

4. Test cap may be used for filling, testing, or draining purposes by connecting to the NPT outlet of the integral ball valve.

5. Install blind flanges with separate means to fill, test, or drain system for testing if test caps are not available from manufacturer.

3.5 VALVE APPLICATIONS

A. Reference Division 23 Sections “General Duty Valves for HVAC Piping” and “Hydronic Piping”.

3.6 EQUIPMENT CONNECTIONS

A. Press to connect joints shall not be provided for equipment connections. Provide flanges, unions, di-electric unions or waterway fittings. Flanges, unions, di-electric unions and waterway fittings are specified in Division 23 Section “Basic Piping Materials and Methods”

3.7 HYDRONIC SPECIALTIES INSTALLATION

A. Reference Division 23 Section “Hydronic Piping Specialties for product requirements.”

B. Strainers:

1. Provide copper press to connect X screwed NPT adapters for 2 inches and smaller.

2. Provide press to connect adapter flanges for 2-1/2 inches to 4 inches.

3. Provide copper grooved adapter flanges for 2-1/2 inches to 8 inches.

3.8 FIELD QUALITY CONTROL

A. The following procedures are paraphrased from the ASME B31.9, code for pressure piping, building services piping.

B. The mechanically joined piping system manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools and installation of grooved joint products.

C. Installing contractor shall schedule training session at project site for all workers that will be installing or handling the grooved piping system. Submit certification letter along with list of attendees to Engineer of Record within 30-days of mobilization. Include copy of certification letter with closeout documents.
D. Provide testing procedures as defined in Division 23 Section "Hydronic Piping" and as specified in grooved mechanical piping manufacturer’s installation instructions.

E. Installing contractor shall visually inspect couplings and repair or replace any misaligned couplings and couplings with gaps prior to calling for substantial completion review as defined in Division 23 Section "Common Work Results for HVAC."

3.9 ADJUSTING AND CLEANING

A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

B. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

3.10 STARTUP

A. See Division 23 Section "Hydronic Piping" for startup procedures.

END OF SECTION
SECTION 232116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes hydronic specialties for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Equipment specified in this Section include:

1. Special Duty Valves:
   a. Circuit Balancing Valves
   b. Automatic Flow-Control Valves

2. Hydronic Specialties:
   a. Air Vents (Manual and Automatic)
   b. Diverting Fittings
   c. Y-Pattern Strainers
   d. T-Pattern Strainers
   e. Metal Flexible Connectors
   f. Combination Piping Packages (Coil Kits).

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 “Concrete” for concrete, reinforcement and formwork for concrete equipment pads.

2. Division 23 Section “Common Work Results for HVAC” for materials and methods for wall and floor penetrations and equipment pads.

3. Division 23 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.

4. Division 23 Section “Common Motor Requirements for HVAC Equipment” for motors related to chemical feeding equipment.

5. Division 23 Section “Hydronic Piping” for material and methods for installation of hydronic piping systems.


1.2 SUBMITTALS

A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.

B. Product Data, including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.

1. Furnish flow and pressure drop curves for diverting fittings and circuit balancing valves, based on manufacturer's testing.

C. Maintenance Data for hydronic specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

D. Welders’ certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.

E. Certification of compliance with ASTM and ANSI manufacturing requirements for hydronic specialties.

1.3 QUALITY ASSURANCE

A. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; Current Edition.

C. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

D. Pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.


1.4 COORDINATION

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.
PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:

1. Circuit Balancing Valves:
   a. American Wheatley.
   b. Armstrong Fluid Technology.
   c. Bell & Gossett; Xylem.
   d. Caleffi.
   e. Griswold Controls.
   f. Hays Fluid Controls.
   g. IMI Hydronic Engineering.
   h. Nexus Valve.
   i. Nibco Inc.
   j. Oventrop.
   k. Pro Hydronic Specialties.
   l. Taco, Inc.
   m. Victaulic (TA Series).

2. Automatic Flow-Control Valves:
   a. Griswold Controls.
   b. Hays Fluid Controls.
   c. IMI Hydronic Engineering.
   d. Nexus Valve.
   e. Pro Hydronic Specialties.
   f. Victaulic (TA Series).

3. Air Vents (manual and automatic):
   a. American Wheatley.
b. Amtrol, Inc.
c. Armstrong International.
d. Bell & Gossett; Xylem.
e. John Wood Company.
f. Nexus Valves.
g. Spirax Sarco.
h. Taco, Inc.

4. Diverting Fittings:
   a. Amtrol, Inc.
   b. Armstrong Fluid Technology.
   c. Bell & Gossett; Xylem.
   d. Taco, Inc.

5. Y-Pattern Strainers:
   a. American Wheatley.
   b. Armstrong International.
   c. Hoffman Specialty; Xylem.
   d. Keckley.
   e. Metraflex Co.
   f. Mueller Steam Specialties.
   g. Spirax Sarco.
   h. Nexus Valve.
   i. Watts Water Technologies.

6. T-Pattern Strainers:
   a. American Wheatley.
   b. Armstrong International.
   c. Keckley.
d. Mueller Steam Specialties.
e. Spirax Sarco.

7. Metal Flexible Connectors:
a. American Wheatley.
b. Duraflex.
c. Hyspan Precision Products.
d. Mason Industries, Inc.
e. Flexicraft Industries.
f. Metraflex Co.
g. Unaflex, Inc.

2.2 GENERAL DUTY VALVES

A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 23 Section "General-Duty Valves for HVAC Piping." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.3 SPECIAL DUTY VALVES

A. Circuit Balancing Valves: Valve shall be rated for 125 psig water working pressure, 250 deg F maximum operating temperature and shall be bronze body with plug or globe style valve and calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valve shall have position indication readout and built-in memory stop for repeatable regulation and control. Valves 2 inch and smaller shall have threaded connections and 2-1/2 inch valves shall have flanged connections.

B. Automatic Flow Control Valves: Valve shall be Class 150, cast iron housing, stainless steel operating parts; threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating pressure differential of 2 through 32 psi. Provide quick disconnect valves for flow measuring equipment. Provide a metal identification tag with chain for each valve, factory marked with the zone identification, valve model number, and flow rate in GPM.

2.4 HYDRONIC SPECIALTIES

A. Manual Air Vent: Manual air vents at heat transfer coils shall be bronze body and nonferrous internal parts; 150 psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge and inlet connections. Manual air vents in piping mains shall consist of a tee fitting, 1/2” ball valve, threaded nipple and cap.
B. Automatic Air Vent: Automatic air vents shall be designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.

C. Diverting Fittings: Diverting fittings shall have cast iron body with threaded ends, or wrought copper with solder ends; and shall be rated for 125 psig working pressure, 250 deg F maximum operating temperature. Indicate flow direction on fitting.

D. Y-Pattern Strainers: Strainers shall be rated for 125 psig working pressure and shall have perforated Type 304 stainless steel basket and bottom drain connection. For general piping strainers, screen openings shall be 0.062” perforations for 4” and smaller and 1/8” perforations for larger than 4”. For strainers upstream of automatic flow control valves, screen openings shall be 20 mesh. Strainers, 2” and smaller, shall have cast bronze body (ASTM B-62), threaded connections and screwed cover. Strainers, larger than 2”, shall have cast-iron body (ASTM A 126, Class B), flanged or grooved ends and bolted cover.

E. T-Pattern Strainers: Strainer shall have ductile iron or malleable iron body rated for 150 psi working pressure, grooved end connections, Type 304 stainless steel strainer basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.

F. Flexible Connectors: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections.

1. Metal Flexible Connectors:
   a. Connections 4 inches and larger: Stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of ¾-inch (20-mm) misalignment.
   b. Connections smaller than 4 inches: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

G. Combination Piping Packages (Coil/Hose Kits):

1. Combination piping packages are allowed in lieu of individual components specified for hydronic coils and devices containing hydronic coils.

2. Components shall be same size as piping serving the unit as shown on the drawings. Control valves do not need to be same size as piping subject to the sizing requirements set forth in Division 23 “Instrumentation and Control Devices for HVAC.”

3. Package shall include the components and shall match layouts specified on the Drawings. Each component of the combination piping package shall meet the specifications for the individual components being combined.
PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. General Duty Valve Applications: General duty valve applications are specified in Division 23 Section “Hydronic Piping”.

B. Circuit Balancing Valves:

1. Variable Volume Pumping Systems:
   a. Install circuit balancing valves where shown on the drawings sized for the smaller of the following:
      1) Line size.
      2) A minimum pressure drop of 1 psi at the design flow rate.

C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

D. Install check valves on each pump discharge and elsewhere as required to control flow direction.

E. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting.

C. Install automatic air vents at air separator outlets, expansion tank connections, high points in outlet piping of boilers and hot water heat exchangers and elsewhere as required for system air venting. Pipe outlet of automatic air vents to discharge at floor drains.

D. Install flexible connectors at inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment. Omit flexible connectors if replaced by series of three grooved couplings on projects where grooved pipe is used.

E. Install strainers on the supply side of each pressure reducing valve, pressure regulating valve, pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

3.3 STARTUP

A. Start up and commissioning of water filtration unit shall be performed by a factory authorized representative.

B. Start up and commissioning of glycol makeup unit shall be performed by a factory authorized representative.
3.4 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water filtration equipment and/or glycol makeup equipment.

B. Training for Owner's personnel shall include but not be limited to:
   1. Overview of the system and/or equipment as it relates to the facility as a whole.
   2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

C. Review manufacturer's safety data sheets for handling of chemicals.

D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 and Division 23 Section "General Mechanical Requirements."

E. Schedule at least four hours of training with Owner, through Architect, with at least seven days' advance notice.

F. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

END OF SECTION
SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of HVAC pumps:

1. Inline circulators.

1.2 RELATED REQUIREMENTS

A. Section 230548 Seismic Controls for Mechanical, for seismic controls.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 specifications:

1. Product data including certified performance curves of selected models indicating selected pump’s operating point, weights (shipping, installed, and operating), furnished specialties, and accessories. For pumps furnished with starter or variable frequency drive, include short circuit current rating of electrical equipment.

2. Shop drawings showing layout and connections for HVAC pumps. Include setting drawings with templates, and directions for installation of foundation bolts and other anchorages.

3. Wiring diagrams detailing wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.

4. Maintenance data for HVAC pumps for inclusion in Operation and Maintenance Data specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.4 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Drawings indicate size, profiles and connections requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Regulatory Requirements: Fabricate and test pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 SPARE PARTS

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

   1. Mechanical Seals: One mechanical seal for each pump.

1.7 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

   1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

   1. Inline Circulators:

      a. Armstrong Pumps, Inc.
      b. Bell & Gossett, ITT.
      c. Taco, Inc.

2.2 PUMPS, GENERAL

A. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.
B. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.

C. Motors: Conform to NEMA Standard MG-1, general purpose, continuous duty, Design B, except Design C where required for high starting torque; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection, and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve. Refer to Section “Common Motor Requirements for HVAC Equipment” for additional requirements.

D. Efficiency:
1. Motors shall have a minimum efficiency meeting the requirements of the Energy Policy Act of 1992 as defined in NEMA MG-1 when tested in accordance with IEEE Standard 112, Test Method B.
2. Motor Frame: NEMA Standard 48 or 54; use pump manufacturer’s standard.
3. Department of Energy Pump Energy Index (PEI): Less than or equal to 1.00 or less than the maximum value scheduled, whichever is less.

E. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 INLINE CIRCULATORS

A. General Description: Circulators shall be horizontal inline, centrifugal, separately-coupled, single-stage, bronze-fitted, radially split case design, with mechanical seals, and rated for 125 psig working pressure and 225 deg F continuous water temperature.

B. Casings Construction: Cast iron, with threaded companion flanges for piping connections smaller than 2-1/2 inches, and threaded gauge tappings at inlet and outlet connections.

C. Impeller Construction: Statically and dynamically balanced, closed, overhung single-suction, fabricated from cast bronze conforming to ASTM B 584, and keyed to shaft.

D. Pump Shaft and Sleeve: Steel shaft, with copper sleeve. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.

E. Mechanical Seals: Carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.

F. Pump Shaft Bearings: Oil-lubricated, bronze journal and thrust bearings.

G. Motor Bearings: Oil lubricated, sleeve type.

H. Pump Couplings: Flexible, capable of absorbing torsional vibration and shaft misalignment.

I. Motors: Resiliently mounted to the pump casing.
PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with the manufacturer's written installation and alignment instructions.

B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

D. Inline pumps shall be supported from adjacent piping using all-thread hanger rod or floor support bars of sufficient size to support the weight of the pump.

3.2 ALIGNMENT

A. General: Comply with pump and coupling manufacturer's written instruction.

B. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.

C. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

C. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

D. Alignment tolerances shall meet manufacturer’s recommendations.

3.3 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Reference details on the drawings for valves and accessories required for each pump.

C. Electrical wiring and connections are specified in Division 26 sections. Ground equipment. Tighten electrical connectors and terminals in accordance with manufacturer's written instructions or those specified in UL486A and UL486B.

D. Control wiring and connections are specified in other Division 23 sections.

3.4 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.
2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.

3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

5. Clean strainers.

6. Check piping connections for tightness.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.

2. Open the valve in the cooling water supply to the bearings, where applicable.

3. Open the cooling water supply valve if the stuffing boxes are water-cooled.

4. Open the sealing liquid supply valve if the pump is so fitted.

5. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.

6. Open the recirculating line valve if the pump should not be operated against dead shutoff.

7. Start the motor.

8. Open the discharge valve slowly.

9. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.

10. Check the general mechanical operation of the pump and motor.

11. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same, except that the discharge gate valve is opened some time before the motor is started.

D. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.
E. Refer to Division 23 Section “Testing, Adjusting, and Balancing for HVAC” for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.5 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION
SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gauge.

2. Wire rope hanging system.

B. Related Sections:

1. Division 7 Section "Penetrations Firestopping," for materials and methods for fire barrier penetrations.

2. Division 7 Section "Joint Sealers," for materials and methods for sealing duct penetrations through basement and foundation walls.


4. Division 23 Section "Common Work Results for HVAC," for materials and methods for wall penetrations and equipment pads.

1.2 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.

2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.
1.4 SUBMITTALS

A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:


B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire-rated and other partitions.
7. Terminal heating and cooling unit, coil, humidifier and duct silencer installations.
8. Locations of fire and fire/smoke dampers and associated duct access doors.
9. Locations of cleanout and access doors in grease exhaust ducts.
10. Location of manual balancing dampers.
11. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.
12. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:

1. Coordination with ceiling suspension members.
2. Spatial coordination with other systems installed in the same space with the duct systems.
3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

D. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section “General Mechanical Requirements” and Division 1.

E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

F. Leak test report for ducts specified to be leak tested in Part 3.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 “Structural Welding Code - Steel” for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

C. NFPA Compliance: Comply with the following NFPA Standards:


E. Underwriter’s Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.


1.6 PROTECTION AND REPLACEMENT

A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.

B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.
PART 2 - PRODUCTS AND MATERIALS

2.1 SHEET METAL MATERIALS

A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A 700.

B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 653, Coating Designation G 90. Provide mill phosphatized or galvanealed finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.

C. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.

D. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SEALING MATERIALS

A. Joint and Seam Sealants, General:

1. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

2. Duct tape shall not be used as a sealant on any ducts.

3. Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.


C. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

D. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 70 percent solids.

1. Manufacturers:

   a. Childers CP-140.

   b. Duro Dyne SGD.

   c. Fosters 32-14.
**METAL DUCTS**

**2.3 FIRE-STOPPING**

A. Fire-Resistant Sealant: Two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Resistant Sealant: One-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

C. Products: Subject to compliance with requirements, provide one of the following:
1. "3M Fire Stop Foam"; 3M Corp.
2. "SPECSEAL Pencil 200 Silicone Foam"; Specify Technology, Inc.
3. 3M Fire Stop Sealant”; 3M Corp.
4. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.

2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.

B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
   1. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
   1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
   2. For stainless steel ducts, provide stainless steel support materials.
   3. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

2.5 RECTANGULAR DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Tables 2-1 through 2-28, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
   1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.
   2. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
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3. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA “HVAC Duct Construction Standards,” 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.

2.6 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA “HVAC Metal Duct Construction Standard,” 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.

B. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

C. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer’s approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section “Ductwork Accessories” for turning vane construction and mounting.

D. Provide full radius elbows for ductwork installed in noise critical spaces. Refer to Section “Basic Mechanical Materials and Methods” for noise critical spaces. Where space does not permit the installation of radius elbows, provide mitered elbows with sound attenuating, acoustical turning vanes. Refer to Section “Ductwork Accessories” for acoustical turning vanes.

2.7 ROUND DUCT FABRICATION

A. General: “Basic Round Diameter” as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.

1. Fabricate round ductwork of minimum 26 gauge sheet metal.

B. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA “HVAC Duct Construction Standards,” 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA “HVAC Duct Construction
Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.

2.8 ROUND SUPPLY AND EXHAUST FITTINGS FABRICATION


B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.
   a. Elbows in Round Duct: Provide full radius elbows.
   b. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
   c. Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section “Basic Mechanical Materials and Methods” for noise critical spaces.


   b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

      1) 3 to 26 inches: 24 gauge.
      2) 27 to 36 inches: 22 gauge.
      3) 37 to 50 inches: 20 gauge.
      4) 52 to 60 inches: 18 gauge.
      5) 62 to 84 inches: 16 gauge.

   c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
1) 3 to 14 inches: 24 gauge.
2) 15 to 26 inches: 22 gauge.
3) 27 to 50 inches: 20 gauge.
4) 52 to 60 inches: 18 gauge.
5) 62 to 84 inches: 16 gauge.

d. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.

3. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

4. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

5. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.


7. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.


2.9 FACTORY-MANUFACTURED DUCTWORK

A. Manufacturers:

1. Hercules Industries.
2. Lewis & Lambert.
3. Lindab Safe.
4. Linx Industries, Inc.
5. Semco.
6. Approved equal.
B. General: At the Contractor’s option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer.

C. Duct Construction

1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10” water gauge pressure with thickness as shown in the following tables:

<table>
<thead>
<tr>
<th>Diameter (Inches)</th>
<th>Galvanized Spiral Duct</th>
<th>Galvanized Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-14</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td>15-24</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>26-42</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>42-60</td>
<td>22</td>
<td>20</td>
</tr>
</tbody>
</table>

2. Duct shall be calibrated to manufacturer's published dimensional tolerance standard.

3. All duct 14” diameter and larger shall be corrugated for added strength and rigidity.

4. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.

5. Ducts shall be constructed using spiral lock seam sheet metal construction.

6. Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.

D. Fittings:

1. All fitting ends for round duct and transitions and divided flow fittings smaller than 50” diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to insure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.

2. All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.

3. All fitting ends from 5” to 60” diameter shall have rolled over edges for added strength and rigidity.

4. All elbows from 5” to 12” diameter shall be 2 piece die stamped and continuously stitch welded. All elbows 14” diameter and larger shall be standing seam gorelock construction and internally sealed.
5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30°, and 60° elbows shall be 1.0 times the elbow diameter.

6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.

7. All volume dampers shall be Lindab Safe type DRU, DSU or DTU or approved equal. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:
   a. Locking quadrant with blade position indicator.
   b. 2" sheet metal insulation stand-off.
   c. Integral shaft/blade assembly.
   d. Shaft mounted, load bearing bushings.
   e. Gasketed shaft penetrations to minimize leakage.

2.10 SNAP-LOCK DUCT SYSTEM

A. General: At Contractor’s option, snap-lock round ductwork can be provided instead of fabricated ductwork for round ductwork up to 14" in diameter in air systems with pressures between negative 1" and positive 2" w.c..

B. Duct Construction:

1. Material:
   a. Galvanized steel conforming to ASTM A653 and A924 with G-60 galvanized coating conforming to ASTM A653 and ASTM A90.

2. Duct shall be minimum 26 gauge. Duct shall be self-locking and incorporate a factory applied gasket in the longitudinal seam and the female end of the traverse joint to provide a system that meets SMACNA Seal Class A.

3. Fittings: Minimum 26 gauge. All high-efficiency take-offs, conicals, and collars shall have a factory applied gasket along all rivets, co-latches, and flanges. Dampered fittings shall have low leakage hardware with closed-end bearings.

C. Gaskets: Butyl and EPDM rubber that meets flame spread index of 25 and smoke spread index of 50 according to ASTM E84.

D. Manufacturers:

1. Ductmate GreenSeam.
2. Approved equal.

PART 3 - EXECUTION

3.1 DUCT MATERIAL APPLICATION

A. All ducts shall be galvanized steel except as follows:

1. Hydrotherapy, Float Pod Exhaust, and locker room Exhaust Ductwork:
   a. Aboveground: Minimum 22 gauge aluminum sheet material.

3.2 DUCT INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Duct System Pressure Class: Construct and install each duct system except factory-manufactured ductwork for the specific duct pressure classification indicated. For factory-manufactured ductwork, refer to Paragraph “Factory-Manufactured Ductwork”.

1. Supply Air Ducts: 3 inches water gauge.
2. Primary Supply Air Ducts (upstream of terminal boxes): 4 inches water gauge.
4. Return and Outdoor Air Ducts: 2 inches water gauge, negative pressure.
5. Exhaust Air Ducts: 2 inches water gauge, negative pressure.

C. Install ducts with the fewest possible joints.

D. Seal duct joints with the appropriate sealing material.

E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.
J. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

K. Install insulated ducts with 1-inch clearance outside of insulation.

L. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

M. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

N. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.

O. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

P. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

3.3 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints as follows:
   1. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.
   2. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized.

B. Seal externally insulated ducts prior to insulation installation.

C. Ductwork installed exterior to the building shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.

D. AEROSOLIZED DUCT SEALING
   1. Application must be performed by a manufacturer approved service provider and the procedure shall be done as per manufacturer's recommendations.
   2. Duct Preparation:
      a. Inspect air distribution system for major leakage and repair major leakage greater than ½ inch externally using mastic and tapes per SMACNA standards.
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b. Inspect air distribution system for significant accumulation of dust, dirt and debris and remove all debris and significant dust and dirt by duct cleaning method.

c. Temporarily remove or protect from aerosol particles building instrumentation and control devices, humidifier dispersion tubes, and fire and smoke sensors. Temporarily isolate air moving equipment and block off air inlets and outlets.

3. Duct Sealing:

a. Seal air distribution system from the inside using automated aerosolized sealant injection.

b. Repair all injection and test holes in existing ductwork sealed tight as per SMACNA standards.

3.4 HANGING AND SUPPORTING


B. Installation of Wire Roper Hanger Systems:

1. Install in accordance with manufacturer’s instructions.

2. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer’s recommended load rating.

3. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.

C. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

D. Support vertical ducts at a maximum interval of 16 feet and at each floor.

E. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.

F. Install concrete insert prior to placing concrete.

G. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.5 PENETRATIONS

A. Fire Barrier Penetrations: Where ducts pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

3.6 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."

C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 7-6 and 7-7. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."

D. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 7-8.

3.7 FIELD QUALITY CONTROL

A. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.

B. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.

3.8 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "TESTING, ADJUSTING, AND BALANCING FOR HVAC" for requirements and procedures for adjusting and balancing air systems.

B. Vacuum duct systems prior to final acceptance to remove dust and debris.

END OF SECTION
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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this Section.

B. Types of ductwork accessories required for project include the following:

1. Dampers.
   a. Low pressure manual dampers.

2. Cable operated damper systems.

3. Turning vanes.

4. Duct hardware.

5. Duct access doors.

6. Flexible ductwork.

7. Metal duct connectors.

C. Refer to other Division 23 Sections for testing, adjusting, and balancing of ductwork accessories; not work of this Section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Codes and Standards:


2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

3. UL Compliance:

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b. Duct tape shall be labeled in accordance with UL Standard 181B and marked 181B-FX.

c. Duct clamps shall be labeled in accordance with UL Standard 181B and marked 181B-C.

4. NFPA Compliance:


5. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 “Surface Burning Characteristics” (NFPA 255) method.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for each type of ductwork accessory including dimensions, capacities and materials of construction; and installation instructions. Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.

B. Shop Drawings: Submit manufacturer’s assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Maintenance Data: Submit manufacturer’s maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS AND MATERIALS

2.1 DAMPERS

A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA “HVAC Duct Construction Standards”.

1. Material: Galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.

2. Construction: Bearings shall be corrosion resistant, molded synthetic and axles shall positively lock into the damper blade. Extended shafts and standoff bracket for insulation clearance shall be metal material. Provide with locking quadrant.

3. Blade Seals: Where dampers are used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.
4. Dampers shall be Greenheck Model MBD Series, or approved equal.

B. Control Dampers: Refer to Division 23 section Instrumentation and Control Devices for HVAC for control dampers; not work of this section.

C. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:

1. Air Balance, Inc.
2. Arrow United Industries.
3. Cesco
4. Greenheck
5. Louvers & Dampers, Inc.
7. Pottorff
9. TAMCO
10. Vent Products

2.2 CABLE OPERATED DAMPER SYSTEMS

A. General: Where access to dampers through a hard ceiling is required, provide a concealed, cable operated volume damper with remote battery operator.

1. Damper shall be adjustable utilizing hand held remote.
2. Route power cabling from damper to operator as indicated on the drawings.

B. Manufacturer: Subject to compliance with requirements, provide cable operated damper systems of one of the following:

1. Metropolitan Air Technology, Inc. Electro-Balance Battery powered dampers.
2. Approved equivalent submitted by the contractor prior to bid.

2.3 TURNING VANES

A. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration. Vanes in ductwork over 30” deep shall be installed in multiple sections with vanes not over 30” long and shall be rigidly fastened. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.
B. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section “Common Work Results for HVAC”.

C. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:

1. Aero Dyne Co.
2. Anemostat Products Div.; Dynamics Corp. of America.
3. Ductmate Industries.
4. Duro Dyne Corp.
5. Elgen Manufacturing Co., Inc.
7. Register & Grille Mfg. Co., Inc.
8. Sheet Metal Connectors, Inc.

2.4 DUCT HARDWARE

A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.

2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12”. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:

1. Ductmate Industries.
2. Elgen Manufacturing Co., Inc.
3. Ventfabrics, Inc.
4. Young Regulator Co.

2.5 DUCT ACCESS DOORS

A. General: Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10” by 10” and maximum size of 24” by 24”. Provide removable section of duct where duct size is too small for a 10” by 10” access door. Construct access doors
in accordance with SMACNA “HVAC Duct Construction Standards – Metal and Flexible” and as specified herein. Label access doors for fire and smoke dampers as specified in Paragraph “Installation of Ductwork Accessories.

B. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one size hinged, other side with one handle-type latch for doors 12” high and smaller, 2 handle-type latches for larger doors.

C. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:

1. Air Balance Inc.
2. Ductmate Industries.
3. Duro Dyne Corp.
4. Register & Grille Mfg. Co., Inc.
6. Ventifabrics, Inc.
7. Vent Products.

2.6 FLEXIBLE DUCT.

A. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regards to required quality of construction and materials. Flexible duct shall have fire retardant polyethylene or reinforced metalized protective vapor barrier as follows:

1. Low pressure (duct pressure class up to and including 2” w.g.) and medium pressure (duct pressure class greater than 2” up to and including 6” w.g.)
   a. Fire retardant polyethylene vapor barrier
      1) ATCO 80 Series
      2) Flexmaster Type 5B
      3) JPL Type PR Series
      4) Thermaflex Type G-KM
   b. Reinforced metalized vapor barrier
      1) ATCO 30 Series
2) Flexmaster Type 5M
3) JPL Type MHP Series
4) Thermaflex Type M-KE

2. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.

3. Provide acoustical, fiberglass insulated duct with minimum R-value of R-4.2.

B. Manufacturer: Subject to compliance with requirements, provide flexible ductwork of one of the following:

1. ATCO Rubber Products.
2. Flexmaster.
3. JPL (J.P. Lamborn Co)
4. Thermaflex.

2.7 METAL DUCT CONNECTORS

A. Description: Factory-fabricated, slide-on transverse flange connectors, corners, cleats, gaskets, and components. Material, gauge, and shape shall match the connecting ductwork.

B. Manufacturers: Subject to compliance with requirements, provide duct connectors by one of the following or approved equal:

1. Ductmate Industries.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Provide balancing dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff
fittings with manual balancing damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.

C. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Vanes shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork.

D. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc., and equipment at the following locations: Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

1. At each change in direction and at maximum 50-foot (15-m) spacing.
2. Upstream from turning vanes.

E. Install flexible duct in accordance with manufacturer’s instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.

1. Flexible duct runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.
2. Flexible ductwork shall be installed straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible duct fully extended minimizing compression.
3. Provide continuous length with no intermediate joints.
4. Support flexible duct from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.
5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.
6. Support straps/saddles shall be minimum 1-1/4” wide. Use of wire hanging systems shall utilize strap and connect wire to strap.
   a. Factory installed suspension systems are acceptable
7. Ductwork shall not be crimped against joist or truss members, pipes, conduits, etc.
8. The bend radius at the center line shall be equal to or greater than one duct diameter.
   a. Support bends approximately one duct diameter on both sides of bends.
9. Connections to ductwork and air devices shall have at least 1” overlap.

F. Provide rigid duct elbow or flexible elbow assembly where a 90 degree elbow is required at connection to air devices.
G. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Construct flexible connections of fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.

H. Install grease exhaust and fire rated duct wrap in accordance with manufacturer's instructions to provide the fire rating of the material as tested per UL requirements. Overlap seams, install stainless steel bands and/or pins to secure wrap to duct and fill annular spaces in floor and wall penetrations with UL rated forming materials and/or putty to maintain the integrity of the system.

I. Install duct silencers at locations indicated on the drawings with straight sections of upstream and downstream ductwork as recommended by the manufacturer.

J. Install acoustical plenums in accordance with manufacturer's written instructions. Support acoustical plenums from the floor or above structure as required for the location shown on the drawings.

K. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".

C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".

D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Extent of air terminals work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of air terminals specified in this section include the following:

1. Variable Air Volume Terminal Units
   a. Shutoff Single Duct

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.

2. AHRI Compliance: Provide air terminals which have been tested and rated in accordance with AHRI 880 "Industry Standard for Air Terminals" and bear AHRI certification seal.

3. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

4. UL/ETL Compliance: Air terminal units shall be UL or ETL listed as a complete assembly. All electrical components shall be UL listed and installed in accordance with the National Electric Code.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, including performance data for each size and type of air terminal furnished; certified sound power data for each unit; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.

B. Nameplate Data: Nameplate data shall be submitted in a timely manner so as to allow proper coordination with the Electrical Contractor. Submittals that do not have nameplate data will be rejected.

C. Shop Drawings: Submit manufacturer’s assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

D. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.
E. Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 1.

1.4 SPARE PARTS

A. If HVAC equipment is used during construction, the contractor is fully responsible for it’s cleaning just before substantial completion prior to testing and balancing.

PART 2 - PRODUCTS AND MATERIALS

2.1 VARIABLE AIR VOLUME TERMINAL UNITS

A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide air terminals of one of the following:

1. Carnes Co.
2. Carrier Corp.; Sub. of United Technologies Corp.
3. Environmental Technologies, Inc.
4. Johnson Controls, Inc.
7. Nailor Industries, Inc.
9. Tempmaster Corp.
11. Trane (The) Co.

C. Casings: Construct of galvanized sheet metal of minimum 22 gauge thickness or die-cast aluminum of minimum 20 gauge thickness.

1. Provide hanger brackets for attachment of supports.
2. Linings: Line inside surfaces of casings with fiberglass, lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Provide minimum thickness of 1/2". Secure lining to prevent delamination, sagging, or settling.
3. Access: Provide removable panels in casings to permit access to air dampers, fans and other parts requiring service, adjusting, or maintenance.
   a. Provide airtight gasket and quarter-turn latches.

4. Leakage: Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage does not exceed 2% of specified air flow capacity with outlets sealed and inlets wide open. Construct air dampers such that when subjected to 6.0-in w.g. inlet pressure with damper closed, total leakage does not exceed 5% of specified air flow capacity.

5. Multiple Duct Connectors: For air terminals serving more than one air outlet, provide lined outlet plenum with duct collar, butterfly-type damper, and locking device in each outlet.

D. Air Dampers: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide maximum volume dampers that are calibrated in cfm, factory-adjusted, and marked for specified air capacities. Provide mechanism to vary air volume thru damper for minimum to maximum, in response from signal from thermostat.

E. Controls: Provide controls accurate to 1.5 degrees F and adjustable from 65 degrees F to 85 degrees F. Provide air flow measurement station at terminal unit inlet. Provide control type as indicated below.
   1. Provide duct pressure powered controls, designed to operate with duct pressures 1.0 to 5.0-in w.g.
   2. Provide direct digital controls, compatible with direct digital control system specified in other Division 23 sections.

F. Identification: Provide label on each unit indicating Plan Number, cfm range, cfm factory-setting, and calibration curve (if required).

G. Units shall incorporate a single point electrical connection for the entire unit. All electrical components shall be UL or ETL listed or recognized and installed in accordance with the National Electrical Code. All electrical components shall be mounted in a control box. The entire assembly shall be UL or ETL listed (cETL in Canada) and so labeled.

H. All sound data shall be compiled in an independent ADC certified laboratory and in accordance with the latest version of AHRI 880. All units shall be AHRI certified and bear the AHRI certification label.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.
B. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.3 ADJUSTING AND CLEANING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

END OF SECTION
SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this Section.

B. Types of outlets and inlets required for project include the following:

1. Ceiling air diffusers.

2. Wall registers and grilles.

C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this Section.

D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this Section.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. AHRI Compliance: Test and rate air outlets and inlets in accordance with AHRI 650 "Standard for Air Outlets and Inlets".

2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.

5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows. Indicate selections on data.

4. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

5. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

C. Color Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

D. Samples for Verification: Provide samples of diffusers, registers, and grilles, in manufacturer's standard sizes, showing the full range of colors. Prepare Samples from the same material to be used for the Work.

1.4 SPARE PARTS

A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

PART 2 - PRODUCTS AND MATERIALS

2.1 CEILING AIR DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Linear Slot Diffusers: Slot diffusers shall be standard one-piece lengths up to 6-feet and shall be furnished in multiple sections greater than 6-feet. Multiple sections shall be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components shall be provided by the manufacturer. Plenums shall be manufactured by the slot diffuser manufacturer. Plenums shall be internally insulated, by the manufacturer, with minimum ¼" thick, closed-cell insulation. Insulation shall not be made of fibrous material.
E. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

F. Manufacturers: Subject to compliance with requirements, provide diffusers of one of the following:
   1. Carnes Co.
   2. Price Industries, Inc.
   4. Metalaire; Metal Industries, Inc.
   5. Nailor Industries, Inc.
   6. Titus HVAC
   7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

2.2 REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

E. Manufacturers: Subject to compliance with requirements, provide registers and grilles of one of the following:
   1. Carnes Co.
   2. Price Industries, Inc.
   4. Metalaire; Metal Industries, Inc.
   5. Nailor Industries, Inc.
   6. Titus HVAC
PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to insure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.

C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 section “Metal Ducts”.

D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

E. Linear Slot Diffuser Installation:

1. For installations in a hard ceiling, install diffuser prior to installation of drywall. Use manufacturer’s hard ceiling clips for mounting to ceiling framing. Screws through face of diffuser are not acceptable.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF SECTION
SECTION 238419 - SWIMMING POOL AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes swimming pool heating and cooling units.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories; and installation and start-up instructions. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

B. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components

2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

C. Wiring Diagrams: Submit wiring diagrams detailing the manufacturer's electrical requirements for power supply wiring for swimming pool air handling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Operation and Maintenance Data: Submit maintenance data and parts list for each unit, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual; in accordance with requirements of Division 1.

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. Gas-fired furnace section construction shall be in accordance with AGA safety standards. Furnace section shall bear the AGA label.

2. Testing and rating of units of 135,000 btu/hr capacity or over shall be in accordance with AHRI 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".

3. Refrigerating system construction of units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

4. Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90.1-2004 "Energy Standard For Buildings Except Low-Rise Residential Buildings".
5. Roof mounted units shall be designed, manufactured, and tested in accordance with UL requirements.

1.4 SPARE PARTS

A. Extra Materials: Furnish to Owner, with receipt, the following spare parts for each roof mounted heating and cooling unit:

1. One set of matched fan belts for each belt-driven fan.
2. One set of spare filters of each type required for each unit. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of installation work, and prior to testing, adjusting, and balancing work.
3. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

1.5 SPECIAL WARRANTY

A. Warranty on Compressor and Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

1. Warranty Period: 5 years from date of substantial completion.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide roof mounted units of one of the following:

1. Dectron.
2. Poolpak.
3. Seresco.

2.2 GENERAL

A. Furnish and install enclosed swimming pool environmental control energy recovery system. The system shall be specifically designed for control of the swimming pool environment. Field assembled or modified commercial grade equipment is not acceptable. Capacities and specifications shall comply with the mechanical schedule. Units shall be completely factory assembled and tested. Outside air, fans, motors, and all operating and safety controls specified shall be furnished, factory installed and factory tested.
B. Units shall be built to comply with UL Standard 465 and be ETL certified and bear the ETL label. The unit’s cooling, heating, and dehumidifying capacity and performance shall meet or exceed that shown on the schedule. System shall include supply air fans, moisture disposal system, and complete logic control system & power for single point connection. Electrical ladder wiring diagrams shall be laminated and attached to the control panel access doors. Installation and maintenance manuals shall be supplied with each unit.

2.3 PRINCIPLE OF OPERATION

A. The unit shall control space temperature and relative humidity, and shall provide controlled ventilation. Warm moist air from the natatorium is drawn over an evaporator coil by the supply fan and the latent and sensible heat is removed from the air. This heat is captured by the R410A refrigeration system with the heat from the compressor. The resulting dryer cooler air is mixed with a fixed amount of outside air to ensure proper indoor air quality. The mixed air is drawn by the supply fan over a re-heating condenser coil and if specified, an auxiliary heating device.

B. The refrigeration system is activated if either the space temperature deviates from, or the relative humidity rises above its set point.

C. The unit shall monitor space and outdoor temperature, relative humidity and pool water temperature.

D. The thermal energy absorbed by the refrigeration system is distributed as follows:
   1. First priority is given to maintaining the natatorium space temperature.
   2. Any remaining heat is then transferred to the auxiliary condenser.

2.4 CABINET CONSTRUCTION

A. Cabinets shall be constructed in a water and air tight manner. The manufacturer's standard cabinet construction shall result in an ASHRAE/ANSI Standard 111-88 Leakage Class of less than four (4) as measured in accordance with AMCA Standard 210-85. Unit serial numbers shall be permanently welded into the base frame.

B. The unit shall be constructed on a welded tubular steel frame. The tubing shall be cold formed carbon steel electric resistant welded square and rectangular type complying to ASTM A-500 Grade B. Minimum yield strength shall be 46,000 psi. The units upper structural tubing frame shall form an integral truss structure when assembled with the wall panels thus greatly increasing the rigidity of the unit. Floors and walls shall be designed to deflect no more than 1/200 of span at unit operating pressures. Formed intermediate cross flooring members shall be constructed of commercial quality hot rolled 11 gauge sheet steel complying to ASTM A-569. The perimeter base frame shall have electrically welded integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. The lifting lug shall be fixed, bolt-down or removable to meet the specific project requirements. Lifting lugs shall be located and sized to allow rigging and handling of the unit. After fabrication and welding, the base frame shall be acid washed and completely coated with 1.5 mils of corrosion resistant zinc rich chromate epoxy primer and top coated. This coating shall exhibit the following characteristics: Pencil hardness of B and sixty degree gloss of less than or equal to for 40 for proper finish adhesion. Adhesion on the actual metal substrate shall comply with ASTM D-3359-B with no lifting. Less than 3/8 in. undercutting shall be exhibited on coatings applied to untreated cold rolled steel panels in a scribed condition after seven (7) days exposure in 5% salt spray testing at 95F and 95% relative
humidity as per ASTM B-117. No blistering or loss of adhesion shall be exhibited to a similar sample subjected to 120 hr humidity test as per ASTM D-2247.

C. Floor Sheets:

1. All floor sheets shall be fabricated of 18 gauge minimum bright galvanized sheet steel which has been continuously hot dip coated with a durable protective coating of zinc. All thickness shall conform to ASTM A-527 for lock-former quality. Zinc coating weight shall be G-90 (1.25 oz/square foot) as per ASTM A-525. Finish shall be bright spangle. All joints shall be sealed with an industrial adhesive sealant for water and air tightness. This sealant shall conform to ASTM C-834-76 and Federal Specification TTS-230C, Class B. Floors shall be double wall and insulated with minimum of 4 in. of fiberglass insulation having an insulating value of no less than R-11.

D. Casing Panels

1. All panels shall be fabricated of 18 gauge sheet steel with 20 gauge solid sheet steel liners. All sheet steel shall be continuously hot dip coated with a durable protective coating of zinc. The steel shall conform to ASTM A-527 for lock-former quality. Zinc coating weight shall be G-90 (1.25 oz/square foot) as per ASTM A-525. Prior to fabrication, both the outer sheet steel shell inner liner will be submerged in a heated phosphoric acid bath to remove all oil and mill scale. A coating of zinc rich epoxy primer shall be applied on both top and reverse sides of each sheet baked on at 400°F. All panel corners will be caulked with sealant. After insulation, liners shall be permanently welded to the outer shell. Panels shall be flange type with a minimum 1 in. flange caulked and sealed to the structural member to form the air seal with the panel. Fasteners used to attach the panel will pass through this flange and into one side of the tube but not penetrating into the air tunnel. Panels shall not exceed 48 in. without a structural steel support member in at least one axis. Panel joints shall be recessed and shall have a mastic coating, insulated and covered with a removable trim strip. All panel joints shall be sealed with an industrial neoprene gasket for water and air tightness.

E. All exterior panels, roof and floor shall be insulated with 2 in. 1.5 Pcf density fiberglass insulation secured with adhesive. Insulation shall not exceed 25 flame spread, 50 fuel contribution, or 50 smoke generation when tested under ASTM E-84 and UL 723. Insulation shall also comply with ASTM C-553-70, C-612-70, Mil -I- 22023C Type I & II Class 5 and Federal Specification HH-I-558-B. Moisture absorption shall be less than 1.14% by weight when exposed for 72 hours to moisture laden air at 120°F and 96% RH.

F. Durable access doors shall be provided into all sections of the air handling equipment for easy access of all components. The doors shall be of the same gauge as the unit cabinet. Access doors shall be double wall and completely insulated between the interior and exterior sheet metal of the door. Insulation shall be the same as that of the unit cabinet. Single wall construction is not acceptable. Each door shall have three (3) - 6 inch stainless steel piano hinges. Access panels without hinges is not acceptable. Ventlok high compression latches shall be used on access doors. All access doors shall be gasketed around the complete perimeter. The gasket shall be a neoprene/EPDM rubber bulb type. All bulb door gasket shall have internal aluminum clips. The bulb gasket shall be rated by the manufacturer for a constant exposure temperature range of -20°F to 160°F. Gasket shall exhibit excellent compression characteristics. Doors shall swing open against the section pressure. Door viewing windows shall be double pane wire reinforced type. All windows shall be fabricated with an integral desiccant between the hermetically sealed panes.
G. The finish coat on the exterior of the unit shall be a high gloss alkyd enamel specially formulated for its weathering characteristic. Epoxy coatings will not be acceptable for outdoor applications due to the UV chalking that occurs during the life of the unit. The total coating thickness shall not be less than 1.5 mils. The color shall be machine gray. Pencil hardness shall be B or greater. Direct impact resistance shall be 30 or greater as per ASTM d-2794. Adhesion on the actual metal substrate shall comply with ASTM D-3359-B with no lifting. In an unscribed condition the coating shall exhibit no visible effects after 100 hours exposure to 100% relative humidity at 100F per ASTM D-2247. Less than 1mm undercutting and no blistering shall be exhibited on coatings applied to untreated cold rolled steel panels in a scribed condition after 100 hr exposure in 5% salt spray testing at 95F and 95% relative humidity as per ASTM B-117. Sixty degree gloss retention after six(6) months South Florida weathering shall not decrease by more than 5%.

H. All water cooled heat exchangers, the compressor, valves, filter dryer and receiver shall be located in a service vestibule separated from the indoor and condenser fan air streams. The vestibule shall be insulated on all surfaces not exposed to the indoor air stream.

2.5 COMPRESSOR

A. Compressors shall be heavy duty, reciprocating, semi-hermetic type. Valves shall be of a disc design to improve volumetric efficiency and to minimize re-expansion of gas. Reed type valves are not acceptable. Bearings shall be Teflon impregnated for longer life and reliability. Internal inherent line break motor protection shall be provided on compressors through 15 horsepower, an external module with internal sensors shall be provided on larger compressors.

B. All reciprocating compressors are to be spring isolated in at least four appropriate points. Spring vibration isolators shall be furnished with a heavy steel retainer, resilient grommet, stabilizing fiber re-reinforced washer and heavy steel center support. Vibrasorbers in line with the crank shaft shall be provided on suction and liquid lines. Springs shall be bolted securely to the compressor assembly. Spring deflection shall be designed for one(1) inch deflection. Isolation springs shall be color coded for easy identification.

C. Capacity reduction shall be supplied with the compressor assembly allowing reduced load starting and variable load operation. The unit shall be supplied with a minimum of two steps total of unloading. Compressors shall have an externally mounted positive displacement oil pump, crankcase heaters and oil level sight glass.

D. Each compressor circuit shall be supplied with a ASME stamped or UL listed receiver to insure no condenser gas bypass and complete draining of the condenser.

E. Each compressor shall be supplied with a sealed replaceable core filter drier located in the liquid line.

2.6 CONDITIONING COILS

A. All coils shall meet or exceed all capacities specified on the mechanical schedule for the project. All water coil performances shall be certified by the manufacturer to be in accordance with A.R.I. Standard 410. Cooling coils shall be mounted in the unit for horizontal air flow. Coil air face velocities shall not exceed the specified velocities of the mechanical schedule. All coils shall be mounted on steel glide channels and fastened to the air seal wall. Coils shall be mounted to air seal wall structure with high strength 0.25 inch bolts, lock washers and nuts. Air seal joints shall be completely caulked with a silicone adhesive sealant.

B. EVAPORATOR COIL
1. Direct expansion coil internal tubes shall be staggered with plate type phenolic coated tempered aluminum fins for maximum performance with minimal air pressure drop. DX coils shall be designed to conform to ANSI-B9.1 Safety Code for Mechanical Refrigeration. Coils shall be tested leak free at 350 psig compressed air under clear water.

2. Internal tubes shall be round seamless 1/2 in., 0.016 in. wall copper tubes which have been deoxidized by the addition of phosphorous. Coils casings shall be constructed of a minimum of 16 gauge continuous galvanized steel. Coil casing reinforcements shall be required for fin lengths over 42 in. Coil fins shall be plate type, die-formed ripple edge corrugated 0.006 in. aluminum with guide channels to create turbulent wiping behind the tubes with collars drawn and belled. Internal copper tubes shall be staggered in direction of air flow. The copper circuiting tubes shall be mechanically expanded to the phenolic coated aluminum or copper fins. Uncoated copper fins will not be accepted. The fin spacing shall be a maximum of 10 fins per inch.

3. Evaporator coils shall contain a holding pressure of dry, carbon dioxide gas when shipped from the factory. Cautionary labels to this effect shall be attached to each coil. The inside of the coil shall be free from flux, scales and any foreign matter. Each coil shall be furnished with a Sporlan brass distributor with solder type connections. The coil shall be face split into two separate circuits, sized proportionally to the compressor capacity reduction. Each circuit shall have a separate liquid line solenoid valve and thermal expansion valve.

4. Evaporator coil section shall have a double wall double pitch drain pan constructed from 18 gauge stainless steel with a 2 in. lip. All corners to be welded water tight. Drain pain is to be a minimum of 2 in. deep with a minimum pitch of 1 in. from high point to the drain outlet connection. Coil condensate drain pan shall be completely insulated. If coils are stacked, an intermediate drain pan is required. This intermediate pan shall drain to the bottom main pan. The coil main pan shall have a 1.25 in. MPT. drain extended to the exterior of the unit.

C. AUXILIARY HOT WATER HEATING COIL

1. Hot water coils shall be tested to 350 psig compressed air under clear water. Coils shall be designed to operate at 200 psig internal pressure and up to 300°F. Internal tubes shall be round seamless 1/2 in., 0.016 in. wall copper tubes which have been deoxidized by the addition of phosphorous. Coils casings shall be constructed of a minimum of 16 gauge continuous galvanized steel [SS or Copper optional]. Coil casing reinforcements shall be required for fin lengths over 42 in. Coil fins shall be plate type, die-formed ripple edge corrugated 0.006 in. aluminum with guide channels to create turbulent wiping behind the tubes with collars drawn and belled. Internal copper tubes shall be staggered in direction of air flow. The copper circuiting tubes shall be mechanically expanded to the phenolic coated aluminum or copper fins. Uncoated copper fins will not be accepted. The fin spacing shall be a maximum of 10 fins per inch.

2. All hot water coils shall be drainable with a 0.25 in. FPT plugged drain or vent tap on the supply and return headers. Seamless copper tubes shall be brazed to the copper supply and return headers.

3. Hot water coil control valve will be furnished and installed by the unit manufacturer.
2.7 AUXILIARY WATER COOLED CONDENSER

A. The pool environmental dehumidifier shall be equipped with an auxiliary water cooled condenser to reject heat if all the compressor heat. The water heat exchanger shall be sized to reject 100% of the compressor heat and the evaporator heat into the auxiliary water. The capacity and specifications shall be according to the schedule. The water heat exchanger shall be pre-piped with a flow detection system installed.

B. The auxiliary cooled condenser shall be of the coaxial tube in tube design. The exchanger shall consist of a copper inner tube mechanically bonded to an outer jacket of copper tubing. A continuous flow cavity shall be formed in the space between the inner tube and outer jacket.

C. Auxiliary water cooled condenser is controlled by a R410A refrigerant diverting valve. If the air heating is satisfied, the diverting valve directs the hot refrigerant gas into the condenser. The water circuit is furnished with CPVC stub-outs for easy connection to the condenser water system.

2.8 AIR FILTERS

A. Filter holding frames shall be of heavy duty construction designed for industrial applications. Holding frames applied in low efficiency filter applications will be upstream accessible. Holding frames shall be constructed from no less than 18 gauge galvanized steel. They shall be equipped with polyurethane foam gaskets, fasteners and filter centering dimples. The in-line depth shall not be less than 2.75 in. in order to effect adequate bearing surface for built-up filter banks. Filter fasteners shall be capable of being installed without the requirement of tools, nuts or bolts. The holding frame shall be designed to accommodate standard size filters with the application of the appropriate type fastener. Holding frame assemblies shall be sized for a maximum of 500 fpm or shall meet or exceed area specified by the mechanical schedule.

2.9 FAN ASSEMBLIES

A. General: The fans shall be single-width single-inlet capable of unhoused operation. Fan wheels shall utilize non-overloading airfoil blades in all sizes. Flat, single thickness blades are not acceptable. Unless otherwise directed, fans shall be in compliance with the layout shown on the drawings.

B. Performance: Fan ratings shall be based on tests made in accordance with AMCA Standard 210 and licensed to bear the AMCA Certified Ratings Seal for Air Performance. Fans not licensed to bear the AMCA Seal for performance shall be tested, at supplier’s expense, in an AMCA Registered Laboratory. Only AMCA certified fans will be accepted. Fans shall have a sharply rising pressure characteristic extending throughout the operating range to ensure quiet and stable operation under all conditions from wide open to closed off. Fan brake horsepower shall be equal to or less than the BHP specified in the schedule at the listed static pressure and CFM.

C. Construction: Support structures shall be fully assembled, heavy gauge, welded construction with integral mounting panel for inlet cone. Unassembled units are not acceptable. Inlet cones shall be aerodynamically designed and spun providing a minimum separation of air flow. Wheel diameters shall be in accordance with the standard dimensions adopted by AMCA for centrifugal fans.

D. Bearings: Bearings shall be grease lubricated, precision anti-friction, self-aligning, foot-mounted pillow block design. Flange mount bearings are not acceptable. Bearings shall be selected for an average minimum 200,000 hour L-50 life when rated at the fan’s maximum cataloged operating speed. All fans shall be provided with high-pressure plastic lube lines internally located on the drive side unless otherwise indicated.
E. Shafts: Shafts shall be ASTM A-108 steel, grade 1040/1045, precision turned, ground and polished. Grade 1018 steel is not acceptable. The shaft's first critical speed shall be at least 120% of the fan's maximum operating speed. The drive end of the fan shaft shall be countersunk for tachometer readings.

F. Finish: All fan surfaces shall be thoroughly prepared prior to painting using a combination of high pressure chemical wash and hand and power tool cleaning as required. After cleaning, all surfaces shall be coated with an industrial grade, alkyd enamel. Surfaces of bolted components not accessible after assembly shall be coated and allowed to dry prior to final assembly. Primer only will not be accepted.

G. Balance and Run Tests: All fan wheels shall be dynamically balanced on precision balancers. Prior to shipment, all fans shall receive a final test balance at the specified operating speed and shall ship fully assembled.

H. Sound Testing: Fan manufacturers shall provide sound power level ratings for fans tested and rated in accordance with AMCA Standards 300 and 301. Sound power ratings shall be in decibels (reference 10-12 watts) in eight octave bands. dBA levels only are not acceptable.

I. Final Inspection: All fans shall receive a final inspection by a qualified inspector prior to shipment. Inspection to include: fan description and accessories, balance, welding, dimensions, bearings, connection points, paint finish and overall workmanship.

2.10 FAN MOTORS

A. Motors shall be NEMA design B with Class F insulation. Motors shall have electrical characteristics and horsepower as specified on the mechanical schedule. All motors shall have a minimum service factor of 1.15. Motors shall have ball bearings. Motors shall be TEFC and high efficiency, and be designed for 1750 RPM. Brake horsepower requirement of the fans shall not exceed 90% of the motor horsepower. The motor shall be located within the unit and mounted on an adjustable heavy steel base. The motor base shall be fastened securely to the structural steel framing of the fan assembly. This entire assembly shall have vibration isolators. Refer to Section “Common Motor Requirements for HVAC Equipment” for additional requirements.

2.11 CONTROL PANEL

A. Each unit shall be equipped with a control panel built as an integral part of the unit. Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with requirements of the latest NEC issue. Where applicable, UL listed components shall be used. Components shall be labeled and wires numbered per the wiring diagram. The unit shall bear the ETL certification label. The control panel shall contain a three pole main power terminal, starters, contactors, three phase overload protection, fuse blocks with fuses, numbered terminal strip, a line voltage to 115 volt control transformer with primary and secondary and control circuit switch.

J. Control panel shall be provided with BacNet connection compatible with building's Johnson Controls Metasys system.

B. The controller shall be micro computer based DDC system. The following functions/setpoints will be programmable at the panel:

1. Indoor Air Temperature

2. Indoor Air Relative Humidity
C. An LED zone terminal will be provided for remote monitoring of the dehumidifier. Remote terminal shall be capable of monitoring of all setpoints listed below:

1. Power On
2. Indoor Air Temperature
3. Indoor Air Relative Humidity
4. Compressor Circuit Fault
5. Compressor Pump Down
6. Compressor Staging
7. Air Heating Mode
8. Air Dehumidification Mode
9. Aux. Air Heating Mode

2.12 CONTROL SENSORS

A. The unit shall be factory supplied with the following factory mounted and wired control sensors:

1. Indoor Air Temperature
2. Indoor Relative Humidity

2.13 UNIT MOUNTED DISCONNECT SWITCH

A. Each unit shall be equipped with a mounted and wired non-fused disconnect switch to meet the NEC requirement for DISCONNECTING MEANS WITHIN THE SIGHT OF THE UNIT.

2.14 ENVIRONMENTAL LOGIC CONTROLS

A. Units shall be provided with temperature controls. Room thermostats shall be mounted and wired by the electrical contractor. Steam or hot water valves shall be installed by the contractor as shown on the plans, and wired by the electrical contractor.

B. The DDC controller controls the heating and cooling in response to a signal from a dual set point transmitter in the controlled space. To maintain stable space temperatures, the controller shall be programmed to balance the room thermostat demand signal against the system output as measured by the sensor located in the discharge duct. The combined space demand and output signal determines the cooling and heating operation. The heating signal opens and closes the air condenser re-heat coil R410A diverting valve in response to the heating demand. This allows hot refrigerant gas from the compressor to enter the coil and provide heat to the space. If this is not sufficient the space temperature will fall and the DDC controller will energize the auxiliary heat.

C. Pool water heating by transferring heat from the refrigeration system is controlled by the two stage aquastat. On a call for pool water heating, and providing flow has been proven by the pool water
flow switch, the pool water refrigerant diverting valve is de-energized. This diverts the hot refrigerant from the auxiliary heat rejection condenser to the pool water heat exchanger. This allows the pool water heat exchanger to pull excess refrigerant heat from the system. The second stage of the aquastat will energize the auxiliary pool water heater.

D. The humidistat located in the space will bring on the compressor at 50% capacity if humidity exceeds setpoint. Should humidity continue to rise the compressor will load fully. This will pull excess moisture from the supplied air. Should heating be required for the space the R410A diverting valve on the reheat coil will open to meet the demand. To achieve optimal sensible and latent cooling control the evaporator is face split into two sections corresponding to the compressor capacity at the unloaded and fully loaded condition. Each section is controlled by a separate refrigerant solenoid valve. If a dehumidification demand exists as sensed by stage 1 of the dehumidistat the refrigerant solenoid valves will open loading the compressor system to meet the load requirements. The fixed position bypass damper above the dehumidification coil is set to provide the required air pressure drop and velocity giving an optimal sensible heat ratio. This will maximize the latent (dehumidification) capacity of the system in the unloaded mode of operation.

E. When first stage of cooling contacts close power is applied through the compressor safeties energizing the liquid line solenoid and time delay relay. This energizes the compressor contacter and oil pressure switch for three minutes before being under control of the low pressure switch. A delay-on-make timer is used to lock out the compressor for five minutes during recycle. Second stage cooling contacts de-energize the unloader solenoid to load the compressor if more cooling is required.

2.15 OPERATING AND SAFETY CONTROLS

A. Each unit shall be provided with a complete operating and safety logic control system. The control system shall shut down the unit in case of high refrigerant pressure, low refrigerant pressure and/or oil failure conditions. The water pump supplying each system will be interlocked (by others) with the pool water pump to provide safe operation. Operating and safety control system shall include all relays, contacters, sensors and switches necessary to operate complete unit.

2.16 FACTORY TESTING AND QUALITY ASSURANCE

A. The fans shall be factory run tested to insure structural integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. Units shall pass quality control and be thoroughly cleaned prior to shipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF SWIMMING POOL AIR HANDLING UNITS

A. General: Comply with the manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative
directs otherwise. Install unit where shown on drawings. Provide adequate clearance around unit for air flow and service.

B. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

D. Ductwork: Refer to Division-23 Section "Metal Ducts". Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

E. Piping: Piping installation requirements are specified in other Division 22 Sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
2. Connection piping to air-handling units with flexible connectors.
3. Connect water supply piping to the air leaving side of water coils.
4. Route unit condensate drain to location shown on the drawings or, if not shown, to nearest indirect waste connection. Provide trap at drain pan, minimum of 1" deeper than fan pressure in inches of water, and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and the following:

<table>
<thead>
<tr>
<th>Piping Length</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 feet</td>
<td>Same size as unit connection</td>
</tr>
<tr>
<td>More than 10 feet</td>
<td>One pipe size larger than unit connection</td>
</tr>
</tbody>
</table>

3.3 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust fan for required airflow in accordance with Division 23 Section “Testing, Adjusting and Balancing for HVAC.” Tighten belts as required for proper operation.

B. Adjust damper linkages for proper damper operation.

C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.4 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

6. Set outside-air and return-air mixing dampers to minimum outside-air setting.

7. Comb coil fins for parallel orientation.

8. Install clean filters. Do not operate air handling unit without pre-filters installed.

9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

10. Disable automatic temperature control operators.

B. Start-Up Services: Complete start-up service shall be provided by the equipment manufacturer's authorized representative and shall include complete sequencing of all controls and unit operation. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
   a. Replace fan and motor pulleys as required to achieve design conditions.
   b. Measure and record motor electrical values for voltage and amperage.
   c. Shut unit down and reconnect automatic temperature control operators.
   d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

3.5 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days’ advance notice.

END OF SECTION
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SECTIONS 260010 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and to all following sections within Division 26.

1.2 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 26 of these Specifications, and Drawings numbered with prefixes E and ME, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers’ requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 DEFINITIONS

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. Furnish: “To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations.”

2. Install: “To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use.”

3. Provide: “To furnish and install complete, and ready for the intended use.”
4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: “An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division.
   a. A Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. Contract Administrator: Where referenced in this Division, “Contract Administrator” is the primary liaison between the Owner and the Contractor. Specifically, for this project this is “the Architect” “the Owner’s Representative” “the Engineer” “the Construction Manager” “Henderson Building Solutions”.

7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.

9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
   a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms “approved equal”, “equivalent”, or “equal” are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
C. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

1.4 REFERENCE STANDARDS

A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, and regulations to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

- IBC International Building Code
- NBC National Building Code
- SBC Standard Southern Building Code
- UBC Uniform Building Code
- ADA Americans with Disabilities Act
- AIA Guidelines for Design and Construction of Hospital and Healthcare Facilities
- AEIC Association of Edison Illuminating Companies
- ANSI American National Standards Institute
- ASTM American Society of Testing Materials
- AWS American Welding Society
- AWWA American Water Works Association
- CSA/USA Canadian Standards Association/USA
- ICEA Insulated Conductors Engineers Association
- IEEE Institute of Electrical and Electronics Engineers
- IES Illuminating Engineering Society
- NBFU National Board of Fire Underwriters
- NEC National Electrical Code, NFPA 70
- NECA National Electrical Contractors Association
- NEMA National Electrical Manufacturers' Association
- NETA InterNational Electrical Testing Association
- NFPA National Fire Protection Association
E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.

G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.

C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.

D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.
1.7 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements, in addition to requirements specified herein.

B. Submittals and shop drawings shall not contain Henderson Engineer’s firm name or logo, nor shall they contain the Henderson Engineer’s seal and signature. They shall not be copies of Henderson Engineer’s work product. If the Contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.

C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division. Provide the number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

F. Refer to individual sections for additional submittal requirements.

G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before electrical construction starts.

H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

I. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor’s stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contractor Administrator’s and Engineer’s designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

K. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

1.8 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

   a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

   b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

   c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.

   d. Same warranty will be furnished for proposed substitution as for specified Work.
e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.

3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.9 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. Contact the Architect for Architect’s written authorization.

D. The following must be received before electronic drawing files will be sent:

   1. Architect’s written authorization
   2. Engineer’s release agreement form
   3. Payment

1.10 QUALITY ASSURANCE

A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

B. Install all work in strict conformance with all manufacturers’ requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.12 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.13 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate
on these Documents changes made from the original Contract Documents. Particular attention
shall be paid to those items which need to be located for servicing. Underground utilities shall be
located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies
of the final drawings and incorporate changes noted on the jobsite work prints onto these
drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked “Record
Drawing”, along with the date. These drawings shall be delivered to the Contract Administrator.

1.14 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to
requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully
identified with manufacturer’s name, make, model, model number, type, size, capacity and
Underwriter’s Laboratories, Inc. labels and other pertinent information necessary to identify the
item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area
and in such a manner as to prevent equipment and materials from damage and loss. Store
equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant
tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer’s
recommendations, and at all times, take every precaution to properly protect equipment and
material from damage, including the erection of temporary shelters to adequately protect
equipment and material stored at the Site. Equipment and/or material which becomes rusted or
damaged shall be replaced or restored by the Contractor to a condition acceptable to the
Contract Administrator.

D. Be responsible for the safe storage of tools, material and equipment.

1.15 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified
herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the
Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship,
design or material for a period of 12 months from date of Substantial Completion, unless specific
items are noted to carry a longer warranty in these Construction Documents or manufacturer’s
standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty
period(s), as stated in the General Conditions and Division 01.

D. Also warrant the following additional items:

1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.

2. All raceway seals are effective.
3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.

E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.

G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.16 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies’ recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.17 FIELD CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building; however, visit the site prior to submitting bid to determine the nature and extent of work involved.

2. Schedule work in the existing building with the Owner.
3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves electrical systems, Light fixtures, equipment, raceways, equipment supports or foundations and materials.

4. Remove articles that are not required for the new work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.

5. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.

6. Finish material will be installed under other divisions.

7. Obtain permission from the Contract Administrator for channeling of floors or walls not specifically noted on the Drawings.

8. Protect adjacent materials indicated to remain. For work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, provide temporary services for affected areas.

B. Use of explosives is not permitted.

C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

(Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.2 EXISTING CONDITIONS

A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new work.
B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.3 EXISTING UTILITIES

A. Prepare and submit a schedule of anticipated utility outages indicating dates and duration. Schedule

B. Schedule and coordinate with the utility companies, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal utility services from any existing utility line. Include all premium time required for all such work in the bid.

C. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or utility companies without additional cost.

D. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.

E. Make repairs and restoration of utilities before workers leave the project at the end of the workday in which the interruption takes place.

F. Include in bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.4 WORK IN EXISTING FACILITIES

A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the site prior to submitting a bid, to determine the nature and extent of work involved.

B. Schedule work in the existing facility with the Owner.

C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves electrical systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.

D. Remove all of these articles that are not required for the new work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.

E. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner’s written permission.

3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
F. Relocate and reconnect all electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical fixtures or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.

G. Finish materials are specified in other divisions.

H. Where removal of existing wiring interrupts electrical continuity of circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued electrical continuity.

I. Channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all channeling not specifically noted on the Drawings.

J. Provide new, typewritten card directory for distribution equipment (including but not limited to load centers, panelboards, switchboards and switchgear) where changes occur under this scope of work. Indicate exact loads served by each existing circuit breaker or switch.

3.5 PERMITS

A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.6 TEMPORARY ELECTRICAL SERVICE AND WIRING

A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.

B. In existing facilities, with Owner’s approval, Contractor may utilize the existing electrical system as the source of temporary power. Coordinate the point of connection and method of connection to the existing system with the Owner’s Representative.

C. The Owner will pay all charges made by the Electrical Utility, with respect to installation and energy charges for temporary services.

D. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.

E. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.

F. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.
G. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).

H. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.

I. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.

J. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.

K. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

3.7 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment To Be Salvaged: remove, demount, disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:

   a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinsh surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.

   b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

3.8 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are
located above inaccessible ceilings. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Maintain all code required clearances and clearances required by manufacturers.

3.9 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.10 CUTTING AND PATCHING

A. Provide all necessary cutting of walls, floors, ceilings and roofs for work under this Division.

B. Cut no structural member without permission from Contract Administrator.

C. Patch around all openings to match adjacent construction.

D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Contract Administrator.

3.11 PAINTING

A. Refer to Division 09 Section “Painting” for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer’s instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or re-finish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
3.12 CLEANSING

A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from the Work and assist in making the premises broom clean. Clean all material and equipment installed under this Division.

C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.

D. Touch up and restore damaged finishes to their original condition.

3.13 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.

B. Check motors for alignment with drive and proper rotation, and adjust as required.

C. Check and test protective devices for specified and required application, and adjust as required.

D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.

E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.

G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.

H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.

J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.

K. Refer to individual sections for additional and specific requirements.

3.14 START-UP OF SYSTEMS

A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers’ recommended torque values using appropriate torque tools.
B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.

C. Adjust taps on each transformer for rated secondary voltages.

D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.

E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.

F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.

G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

3.15 TEST REPORTS

A. Perform tests as required by these Specifications and submit the results in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.

B. For specific testing requirements of special systems, refer to the Specification section that describes that system.

C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:

1. Building service entrance voltage and amperes at each phase.
2. Electrical service grounding conditions and grounding resistance.
3. Proper phasing throughout the entire system.
4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
5. Phase voltages and amperes at each three-phase motor.
6. Test all wiring devices for electrical continuity and proper polarity of connections.
D. Promptly correct all failures or deficiencies revealed by these tests as determined by the Engineer.

3.16 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
   1. Submit complete Operation and Maintenance Data.
   2. Submit complete Record Drawings.
   3. Perform all required training of Owner’s personnel.
   4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
   5. Perform start-up tests of all systems.
   6. Remove all temporary facilities from the site.
   7. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.

B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator will prepare a “final list” of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION
SUBSTITUTION REQUEST FORM

To Project Engineer: __________________________ Request # (GC Determined): ________________

Project Name: _______________________________________________________________________

Project No/Phase: __________________________ Date: __________________________

Specification Title: __________________________________________________________________

Section Number: ____________ Page: ________ Article/Paragraph: _______

Proposed Substitution: ______________________________________________________________________

____________________________________________________________________________________

Manufacturer: __________________________ Model No.: ______________________

Address: __________________________ Phone: ______________________

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

Differences between proposed substitution and specified Work: ________________________________

____________________________________________________________________________________

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: ________________

Reason for not providing specified item: ________________________________________________

____________________________________________________________________________________

Similar Installation:

Project: __________________________ Architect: ______________________

Address: __________________________ Owner: ______________________

________________________________________ Date Installed: ______________________

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

____________________________________________________________________________________

GENERAL ELECTRICAL REQUIREMENTS

260010-19
Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_________________________  ______________________  ______________________
Submitting Contractor        Date                      Company

Manufacturer’s Certification of Equal Quality:

I ___________________ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_________________________  ______________________  ______________________
Manufacturer’s Representative Date                      Company

Engineer Review and Recommendation Section

Recommend Acceptance  □ Yes  □ No
Additional Comments: □ Attached  □ None

Acceptance Section:

_________________________  ______________________  ______________________
Contractor Acceptance Signature Date                      Company

_________________________  ______________________  ______________________
Owner Acceptance Signature Date                      Company

_________________________  ______________________  ______________________
Architect Acceptance Signature Date                      Company

_________________________  ______________________  ______________________
Engineer Acceptance Signature Date                      Company
SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:

1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
2. Sleeves and seals for electrical penetrations.
3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
4. Sealing penetrations through noise critical spaces.

1.2 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these Specifications:

1. AHJ: Authority(ies) having Jurisdiction
2. ATS: Acceptance Testing Specifications
3. EPDM: Ethylene-propylene-diene monomer rubber
4. MC: Metal Clad
5. NBR: Acrylonitrile-butadiene rubber
6. NRTL: Nationally Recognized Testing Laboratory
7. PCF: Pounds per Cubic Foot

B. The following definitions apply to this and other Sections of these Specifications:

1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.

4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

1. Product data for the following products:
   a. Sleeve seals.
   b. Through and membrane penetration firestopping systems.
   c. Joint sealers
   d. Acoustical sealers

2. Shop drawings for:
   a. Detailed fabrication drawings of access panels and doors.

3. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
   a. Where Project conditions require modification to qualified testing and inspecting agency’s illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer’s fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
   b. Qualifications data for testing agency.

4. Record Drawings: Submit Record Drawings as required by Division 1 and Division 26
a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

1.5 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.

1. Meeting/Banquet Rooms

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:
1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section “Identification for Electrical Systems” for labeling of access doors.

2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

3. Access doors must be of the proper construction for type of construction where installed.

4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.

5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
   a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
   b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
   c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
   a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.


9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.3 SLEEVES

A. Steel sleeves for raceways and cables

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

B. Cast iron wall pipe sleeves for raceways and cables

1. Manufacturers
c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
d. Watts Industries, Inc.
e. Zurn Industries, Inc.; Hydromechanics Div.

2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with setscrews.

3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.4 SEALANTS

A. SLEEVE SEALS

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

2. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. O-Z/Gedney
   e. Pipeline Seal and Insulator, Inc.

3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.
   a. EPDM
   b. NBR
   c. Neoprene

4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.
   a. Plastic
b. Carbon steel

c. Stainless steel

d. PVC-coated steel

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

a. Carbon steel with corrosion-resistant coating

b. Stainless steel

B. JOINT SEALERS

1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.

3. Elastomeric Joint Sealers: Provide the following types:

a. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

b. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

c. Products: Subject to compliance with requirements, provide one of the following:

1) One-Part, Nonacid-Curing, Silicone Sealant:

   a) "Dow Corning 790," Dow Corning Corp.
   b) "Dow Corning 795," Dow Corning Corp.
   c) "Silglaze N SCS 2801," General Electric Co.
   e) "864," Pecora Corp.
   f) "Omniseal," Sonneborn Building Products Div
   g) "Spectrem 1," Tremco, Inc.
   h) "Spectrem 2," Tremco, Inc.
2) One-Part, Mildew-Resistant, Silicone Sealant:
   a) "Dow Corning 786," Dow Corning Corp.
   b) "Sanitary 1700," General Electric Co.
   c) "898 Silicone Sanitary Sealant," Pecora Corp.
   d) "OmniPlus," Sonneborn Building Products Div.
   e) "Tremsil 600 White," Tremco Corp.

4. Acrylic-Emulsion Sealants: One-part, non-sagging, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

   a. Products: Subject to compliance with requirements, provide one of the following:
      1) "Chem-Calk 600," Bostik
      2) "AC-20," Pecora Corp.
      3) "Sonolac," Sonneborn Building Products Div.
      4) "Tremflex 834," Tremco, Inc.

C. FIRESTOPPING

1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters’ Laboratories, Inc., or other NRTL acceptable to AHJ.

   a. Available Manufacturers:
      1) Hilti, Inc.
      2) RectorSeal.
      3) Specified Technologies Inc.
      4) 3M Corp.
      5) United States Gypsum Company.

D. ACOUSTICAL SEALANTS

1. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.

2. Non-Hardening Penetration Sealant: Non-hardening polysulphide type, Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
3. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section “Penetration Firestopping”.

C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

D. Comply with NECA 1.

E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.

F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

H. Right of Way: Yield to raceways and piping systems installed at a required slope.

3.2 ACCESS DOORS

A. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

C. Label all access doors with a nameplate as described in Division 26 Section “Identification for Electrical Systems”.

3.3 SLEEVES AND SLEEVE SEALS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.
C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.

D. New Construction:
   1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.

E. Construction in Existing Facilities:
   1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Contract Administrator, Owner, or both. Seal sleeves into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Contract Administrator.

F. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.

G. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

H. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

I. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

J. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.

K. Cut sleeves to length for mounting flush with both surfaces of walls.

L. Extend sleeves installed in floors 2 inches above finished floor level.

M. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed; in which case, size sleeves as recommended by the seal manufacturer.

N. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

O. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
P. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

Q. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
   a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
   b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
   c. Install galvanized sheet metal for rectangular sleeves
   d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

R. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.

S. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

T. Sleeve-Seal Installation

1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.

2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

U. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.
3.4 **FIRESTOPPING**

A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.5 **JOINT SEALERS**

A. Preparation for Joint Sealers

1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.

2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

B. Application of Joint Sealers

1. General: Comply with joint sealer manufacturers’ printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

   a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.


2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.6 **ACOUSTICAL PENETRATIONS**

A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.

B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary,
to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION
SECTION 260502 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.

B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and rough-in requirements based on shop drawings.

D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

E. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product data for the following products for:

1. Special connectors

2. Special conductors or cable assemblies.

C. Shop drawings for:

3. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

4. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.

5. Marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 CORDS AND CAPS

A. Attachment Plugs: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.

C. Cord: See Paragraph “Flexible Cords” in Division 26 Section “Low-voltage Electrical Power Conductors and Cables”.

D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.3 ELECTRICAL DEVICES

A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.4 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturers’ instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.5 HVAC EQUIPMENT

A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier’s installation drawings.

C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.

3.6 DOOR OPERATORS AND HARDWARE

A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier’s installation drawings.

C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.

D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.

END OF SECTION
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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Conductors, cables, and cords rated 600V and less.
2. Connectors and terminations rated 600V and less.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Division 26 Section “General Electrical Requirements” for general requirements and related documents that apply to this Section.

B. Division 26 Section “Common Work Results for Electrical” for sleeves and seals for electrical penetrations.

C. Division 26 Section “Grounding and Bonding for Electrical Systems” for conductors and connectors for grounding systems.

D. Division 26 Section “Equipment Wiring Systems” for electrical connections to equipment specified under other Sections, Divisions, or furnished by the Owner.

   1. Division 28 Section “Digital, Addressable Fire-Alarm System” for fire alarm wiring.

E. Division 23 Section “Direct-Digital Control for HVAC” for temperature control wiring.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:

   1. Product data for the following products:

      a. Metal Clad (MC) cable and fittings.

B. Qualification Data: For testing agency.

C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

1.4 ABBREVIATIONS AND DEFINITIONS

A. The following abbreviations apply to this and other Sections of these specifications:

   1. MC: Metal Clad
2. NBR: Acrylonitrile-butadiene rubber

B. The following definitions apply to this and other Sections of these Specifications:

1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

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

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

2. Marked for intended use.

E. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 CONDUCTORS AND CABLES

A. General

1. Manufacturers:
   a. AFC Cable Systems, Inc.
   b. Alan Wire
   c. Cerrowire
   d. Colonial Wire & Cable
   e. Encore Wire Corporation
   f. General Cable
   g. Northern Cables Inc.
   h. Okonite Company
   i. Southwire Company

2. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable; conductor for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger and stranded for all flexible cords, cables, and control wiring.

3. Conductor Insulation Types: Type THW, THHN/THWN-2 and/or XHHW-2 complying with ICEA S-95-658/NEMA WC70 or as noted otherwise below.

4. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).

5. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.

6. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

B. Metal Clad Cable, Type MC (for non-patient care areas only. Do not use for life safety or critical systems.)

1. MC Cable (with insulated green grounding conductor, no bonding conductor):
   a. Manufacturers:
1) AFC Cable Systems, Inc (MC Lite)
2) Encore Wire Corporation (MC)
3) Kaf-Tech
4) Southwire Company (Amorlite)

b. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.

c. Armor Assembly: Aluminum interlocked armor (aluminum color).


e. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NEC Table 250.122.

f. Marking: Cable markings shall comply with the requirements on NEC ART. 310.11.

2. MC Cable (with 0-10V dimming control wiring):

a. Manufacturers:
   1) AFC Cable Systems, Inc (MC-PCS)
   2) Encore Wire Corporation (MC-LED)
   3) Southwire Company (MC – PCS Duo)

b. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.

c. Armor Assembly: Aluminum interlocked armor (aluminum color).


e. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NEC Table 250.122.

f. Control Conductors: color coded class2/class3 twisted jacketed pairs

g. Marking: Cable markings shall comply with the requirements of NEC Art 310.11(1).

3. MC Cable Fittings:
a. Manufacturer & Model:

1) Arlington (4010 AST snap-in type): (SG38 saddle type)
2) Crouse-Hinds (QLK Quick-Lok Series, Saddle type); ACB Series; set-screw, saddle type)
3) O-Z Gedney (AMC-50 speed-lok, saddle type)
4) Thomas & Betts (XC-730 Series cable-lok, saddle type); 3110 Series Tite-Bite)

b. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.

c. Fittings shall be insulated type not requiring the use of anti-short bushings.

d. Romex style, clamp type fittings are not acceptable.

C. Flexible Cords

1. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, extra-hard-usage; Type SO for indoor dry and damp locations; SOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

2. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, hard-usage; Type SJ for indoor dry locations, SJOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

D. Control Wiring

1. Refer to Division 23 Section “Direct-Digital Control for HVAC”

2. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

E. Connectors

1. Manufacturers:
   a. AMP; Tyco
   b. FCI-Burndy
   c. Gould
   d. Ideal Industries, Inc.
e. Ilsco
f. NSi Industries, Inc.
g. O-Z/Gedney
h. Panduit
i. Thomas and Betts
j. 3-M Electrical Products Division

2. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, tinned copper, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple overlapping layers of 3-M Scotch electrical tape.
   a. Termination fittings: 1- or 2-hole pad and inspection port.

3. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, bare copper, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple overlapping layers of 3-M Scotch electrical tape.
   a. Termination fittings: 1- or 2-hole pad and inspection port.


5. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: flanged fork or ring-tongue type.

PART 3 - EXECUTION

3.1 CONDUCTORS AND CABLES

A. General:

1. Unless otherwise indicated on the Drawings on in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 8 inches of conductor at outlets for fixture or device connections.

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

3. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
4. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.

5. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).

6. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.

7. Seal around cables penetrating fire-rated elements according to Division 07 Section "Penetration Firestopping".

8. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems".

9. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.

10. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.

11. Multi-wire branch circuits (i.e., shared neutral) shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two example.

12. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:

   a. Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.
      1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.
      2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
   b. Normal or Non-Essential circuits.
      1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight...
conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.

2) The minimum wire size for all conductors in this raceway: No. 10 AWG.

3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

c. GFCI-protected circuits.

1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.

13. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.

14. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.

15. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:

a. Wet or dry locations, in raceways:

1) Service entrance: Type THWN, THHN/THWN-2, or XHHW.

2) Feeders and branch circuits: Type THWN, THHN/THWN-2, or XHHW.

3) Conductors No. 6 AWG and smaller: Types THWN or THHN/THWN-2.

b. Fluorescent light fixtures or conductors within three feet of high temperature equipment such as heaters: Type THHN, XHHW, or higher temperature insulation as required for the use.

B. Metal Clad Type MC Cable:

1. Securing and Supporting:

a. Support per Art 330 for MC cable

b. Secure cable within 12 inches of every box or fitting.

c. Secure/supporting intervals shall not exceed six (6) feet for MC cable.

d. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.

2. Type MC cable may only be used:
a. In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.

3. MC Cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:
   a. In locations not permitted by the NEC.
   b. When specifically not allowed by the local AHJ and/or University.
   c. Homeruns to panelboards. Note: where metal clad cable is utilized for receptacle, lighting, and/or miscellaneous load branch circuiting, the originating point of the homerun shall be at the first (most upstream) load in the circuit or at a junction box located in the accessible ceiling space immediately above the first (most upstream) load. Reference definitions in this section for definition on "Homerun".
   d. Where exposed to view
   e. Where subject to physical damage.
   f. Corrosive or Hazardous locations.
   g. Wet locations.
   h. Emergency circuits covered by NFPA Art 700 Emergency Systems
   i. For vertical drops and horizontal wiring in stud walls.

C. Flexible Cords
   1. Refer to Division 26 Section, “Equipment Wiring Systems”, for electrical connections to equipment.

D. Control Wiring
   1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
   2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.

E. Connections:
   1. Apply a zinc based, anti-oxidizing compound to connections.
2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

4. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

5. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.

6. Connect conductors No. 6 AWG and larger to panelboards and apparatus by means of approved mechanical lugs or compression connectors.

7. Do not use terminals on wiring devices to feed through to the next device.

3.2 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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.

B. This Section includes:
   1. Grounding Conductors
   2. Connector Products
   3. Grounding Electrodes
   4. Ground Bars
   5. Miscellaneous Grounding Materials and Products

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Division 26 Section “General Electrical Requirements” for general requirements and related documents that apply to this section.

B. Division 26 Section “Low-voltage Electrical Power Conductors and Cables” for insulated conductors.

C. Division 26 Section “Raceway and Boxes for Electrical Systems” for raceways.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:
   1. Product data for the following products:
      a. Electrodes, mechanical and compression connectors, and exothermic connectors.

B. Qualification Data: For Contractor.

C. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:
   1. Accurately record actual locations of all exterior buried electrodes and all buried ground rings. Indicate dimensions from fixed structural elements.
1.4 DEFINITIONS

A. The following apply to this and other Sections of these Specifications:

1. EMT: Electrical metallic tubing.
2. ENT: Electrical nonmetallic tubing.
3. FMC: Flexible metal conduit.
5. LFMC: Liquidtight flexible metal conduit.
6. LFNC: Liquidtight flexible nonmetallic conduit.
7. RMC: Rigid Metal Conduit
8. GRS: Galvanized Rigid Steel Conduit
9. RAC: Rigid Aluminum Conduit
10. RNC: Rigid nonmetallic conduit.
11. PSF: Pounds per Square Foot

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS (current version), “Suitability of Test Equipment” and “Test Instrument Calibration.”

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

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
2. Marked for intended use.
3. Comply with UL 467.

E. Comply with NFPA 70.
PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

A. Available Manufacturers:

1. Apache Grounding/Erico Inc.
2. Boggs, Inc.
3. Chance/Hubbell.
4. Copperweld Corp.
5. Dossert Corp.
7. FCI/Burndy Electrical.
8. Galvan Industries, Inc.
11. Heary Brothers Lightning Protection Co.
12. Ideal Industries, Inc.
13. ILSCO.
15. Korns: C. C. Korns Co.; Division of Robroy Industries.
16. Lightning Master Corp.
17. Lyncole XIT Grounding.
19. Panduit, Inc
20. Raco, Inc.; Division of Hubbell.
24. Thomas & Betts, Electrical.

2.3 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Common Work Results for Electrical."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.

E. Bare Copper Conductors: Comply with the following:


F. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.

G. Grounding Bus: UL & cUL Listed to UL467 & C22.2 respectively, pre-drilled per TIA/EIA Standard 607, bare, 1/4 inch thick, electrolytic, tough pitch copper bar, length and width as indicated on the Drawings; insulators and standoffs as specified in Paragraph "Ground Bars" below.
2.4   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

   1. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:

      a. Company symbol and/or logo.
      b. Catalog number.
      c. Conductors accommodated.
      d. Installation die index number or die catalog number is required.
      e. Underwriters Laboratories “Listing Mark:”.
      f. The words “Suitable for Direct Burial” or, where space is limited, “Direct Burial” or “Burial” per UL Standard ANSI/UL467 (latest revision).

   2. Cast connectors: copper base alloy according to ASTM B 30 (latest revision).

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

2.5   GROUNDING ELECTRODES

A. Ground Rods: UL-listed:

   1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
   2. Hot-dip galvanized steel; minimum zinc thickness specified per ASTM A-123
   3. Stainless steel; Type 304
   4. Size: 5/8 inch by 8 feet. Provide sectional types when longer rods are indicated.

2.6   GROUND BARS

A. Rectangular Ground Bars: UL & cUL Listed to UL467 & C22.2 respectively, pre-drilled per TIA/EIA Standard 607, bare, 1/4 inch thick, electrolytic, tough pitch copper bar, length and width as indicated on the Drawings.

B. Supports: Minimum of two each 1-1/2-inch insulators and 1-inch stainless steel offset mounting brackets.
PART 3 - EXECUTION

3.1 GENERAL

A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

B. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of the NEC and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.

C. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.

3.2 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 branch circuit and feeder raceways, use insulated equipment grounding conductors.

3.3 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and branch circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Feeders and branch circuits installed in non-metallic raceways.

D. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding
electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.

E. Busway Supply Circuits: Install an insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panelboard to the equipment grounding bar terminal on the busway, if a direct bus-to-bus connection is not factory provided.

F. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

G. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components. On water heaters, bond metal hot and cold water pipes together, across the heater tank.

H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 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.

3.4 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

3. Verify that final backfill and compaction has been completed before driving rod electrodes.

B. Grounding Conductors: Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 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.

C. 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.
D. **Metal Water Service Pipe:** Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. **Water Meter Piping:** Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. **Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.**

G. **Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.**

### 3.5 CONNECTIONS

A. **General:** Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

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. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:

1. Connecting conductors together.

2. Connecting conductors to ground rods, except at test wells.

3. Connecting conductors to building steel.

4. Connecting conductors to plates.

C. **Compression Fittings:** Permanent compression-type fittings may be used for the following rather than exothermic connections:
1. Connecting conductors together.

2. Connecting conductors to building steel.

3. Connecting conductors to ground rods, except at test wells.

D. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:

1. Connecting conductors to ground rods at test wells.

2. Connecting conductors to pipes.

E. 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.

F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

G. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

H. 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.

I. 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.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

4. Test Values:
   a. The resistance between the main grounding electrode and earth ground shall be no greater than 10 ohms.
   b. Equipment Rated 500 kVA and Less: 10 ohms.
   c. Equipment Rated 500 to 1000 kVA: 5 ohms.
   d. Equipment Rated More Than 1000 kVA: 3 ohms.

5. Perform point–to–point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.


7. Investigate point-to-point resistance values that exceed 0.5 ohms.
   a. Check for loose connections.
   b. Check for absent or broken connections.
   c. Check for poor quality welds.
   d. Consider other reasons.

8. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, notify Architect promptly and include recommendations and costs to reduce them.

END OF SECTION
SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 26 Section “General Electrical Requirements” for general requirements and related documents that apply to this Section.

B. Division 26 Section “Common Work Results for Electrical” for concrete pads for pad-mounted service transformers.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.
B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Quality procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

      a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

   A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

   B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

   A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 and/or Spring-tension clamps.

7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
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SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 26 Section “General Electrical Requirements” for general requirements and related documents that apply to this Section.

B. Division 26 Section “Common Work Results for Electrical” for limited scope general construction materials and methods.

C. Division 26 Section “Equipment Wiring Systems” for electrical connections to equipment specified under other Sections, Divisions, or furnished by the Owner.

D. Division 26 Section “Grounding and Bonding”.

E. Division 26 Section “Hangers and Supports for Electrical Systems”.

F. Division 26 Section “Under Floor Raceways for Electrical Systems”.

G. Division 26 Section “Underground Ducts and Raceways for Electrical Systems”.

H. Division 26 Section “Identification for Electrical Systems”.

I. Division 26 Section "Wiring Devices" for devices installed in boxes, power poles, and multi-outlet assemblies.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:

1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in path of conduit groups with supports.
2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

1.4 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. EMT: Electrical Metallic Tubing
2. FMC: Flexible Metal Conduit
3. GRS: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. LFNC: Liquidtight Flexible Nonmetallic Conduit
7. RAC: Rigid Aluminum Conduit
8. RMC: Rigid Metal Conduit
9. RNC: Rigid Nonmetallic Conduit

1.5 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
2. Marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2.2 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

A. Metal Conduit And Tubing

1. Available Manufacturers:
   a. AFC Cable Systems, Inc.
   b. Alflex Corporation, a Southwire Company
   c. Anamet Electrical, Inc.; Anaconda Metal Hose.
   d. Electri-Flex Co.
   e. Indalex
   f. Manhattan/CDT/Cole-Flex
   g. O-Z/Gedney; Unit of General Signal (Fittings)
   h. Republic Raceway
   i. Tyco International; Allied Tube & Conduit Div.
   j. Western Tube and Conduit Corporation
   k. Wheatland Tube Co.

2. RMC:
   b. RAC: ANSI C80.5, UL6A.

3. IMC: ANSI C80.6, UL 1242.

4. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.

5. Plastic-Coated IMC and Fittings: NEMA RN 1, UL-listed.

6. EMT and Fittings: ANSI C80.3, UL 797.
   a. Fittings: Compression type.

7. FMC: Aluminum or Zinc-coated steel: UL 1.

8. LFMC: Flexible steel raceway with PVC jacket: UL 360.
   a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway
1. Available Manufacturers:
   a. AFC Cable Systems, Inc. (Tubing)
   c. Anamet Electrical, Inc.; Anaconda Metal Hose.
   d. Arnco Corp.
   e. Cantex Inc.
   g. Condux International.
   h. ElecSYS, Inc.
   i. Electri-Flex Co.
   j. Lamson & Sessions; Carlon Electrical Products.
   k. Manhattan/CDT/Cole-Flex.
   l. Prime Conduit (formerly Carlon)
   m. RACO; Division of Hubbell, Inc.
   n. Spiralduct, Inc./AFC Cable Systems, Inc.
   o. Superflex Ltd.
   p. Thomas & Betts Corporation.

2. RNC: Schedule 40 and 80 PVC: NEMA TC 2, UL 651.
   a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.

C. Metal Wireways

1. Available Manufacturers:
   a. Cooper B-Line
   b. EPI-Electrical Enclosures
   c. Hoffman.
   d. Square D.
2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA rating as required for environment.

3. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.

4. Wireway Covers: Screw-cover type.

5. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.

D. Nonmetallic Wireways

1. Available Manufacturers:
   a. Enduro Composite Systems
   b. Hoffman.
   c. Lamson & Sessions; Carlon Electrical Products.

2. Description: Fiberglass reinforced polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Gasketed cover with oil-resistant gasket material and fastened with corrosion resistance captive screws; flanged connections, with stainless-steel screws and oil-resistant gaskets.

3. Description: PVC, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

4. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

5. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.3 BOXES, ENCLOSURES AND CABINETS

A. General

1. Available Manufacturers:
   a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   b. Emerson/General Signal; Appleton Electric Company.
   c. Erickson Electrical Equipment Co.
   d. Hoffman.
e. Hubbell, Inc.
f. Killark Electric Manufacturing Co.
g. O-Z/Gedney; Unit of General Signal.
h. RACO; Division of Hubbell, Inc.
i. Robroy Industries, Inc.; Enclosure Division.
j. Scott Fetzer Co.; Adalet-PLM Division.
k. Spring City Electrical Manufacturing Co.
l. Thomas & Betts Corporation.
m. Walker Systems, Inc.; Wiremold Company (The).
n. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary

B. Outlet Boxes

1. Sheet Metal Outlet and Device Boxes: NEMA OS 1; UL514A.
2. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

3. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the following paragraphs. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Available Manufacturers listed above and models that meet the specified criteria.

a. Boxes for exposed work: deep drawn type with raised covers:
   1) Appleton 4S 1/2-DR; 8300 series cover.
   2) RACO 190 series; 800 series cover.
   3) Steel City 52150 series; RS series cover.

b. Concealed and exposed boxes for lighting:
   2) RACO 160 series.
   3) Steel City 54170 series.

c. Boxes imbedded in concrete for lighting:
   1) Appleton OCR
2) RACO 270 or 280 series.
3) Steel City 54500 series.

d. Boxes for flush switches, receptacles, or other general devices:
   1) Appleton 4SVB series; 8400 series cover.
   2) RACO 198 series; 770 series cover.
   3) Steel City CWV series; 52-C-00 series cover.

e. Boxes for flush switches, receptacles, or other general devices installed in masonry construction:
   1) Appleton MI-250 series or MI-350 series.
   2) RACO 690 series or 960 series.
   3) Steel City GW series.

f. Boxes for telephone, data, telecommunications and audio-video outlets, refer to Division 27 Section “Common Work Results for Communications”.

g. Exposed weatherproof boxes for general devices: cast aluminum with mounting lugs and neoprene gasket:
   1) Appleton FDB series.
   2) RACO 5300 series.
   3) Steel City T100L or LT100L series.

h. Exposed weatherproof boxes for general devices: cast aluminum with neoprene gasket:
   1) Appleton FS series.
   2) RACO 5300 series.
   3) Steel City T100 or LT100 series.

C. Junction and Pull Boxes
   1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
   2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

D. Floor Boxes
   1. General:
a. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the tables below. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Available Manufacturers listed above and models that meet the specified criteria.

b. Floor boxes used for power: Include a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle unless noted or scheduled otherwise on the Drawings. Wiring device color: Refer to Division 26 Section “Wiring Devices”, or as indicated on the Drawings.

c. Floor boxes utilized for telephone, data, or both: Include provisions for mounting telephone/data outlets in accordance with the requirements of the telephone/data systems provider.

d. UL514A listed for scrub water exclusion for all floor types.

2. Box Type A: For slab on grade: round-faced, watertight, Class 1, fully adjustable cast iron box. For slab above grade: round-faced, concrete-tight, fully adjustable, stamped galvanized steel box. Brass cover plate and brass carpet ring. Provide aluminum cover plate and trim in lieu of brass when directed by Architect. Provide shallow boxes where necessitated by slab depth.

<table>
<thead>
<tr>
<th>MFR</th>
<th>CAST IRON BOX</th>
<th>STAMPED STEEL BOX</th>
<th>COVER PLATE (POWER)</th>
<th>COVER PLATE (TEL/DATA)</th>
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<td>P60-3/4-2</td>
<td>P60-CP</td>
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3. Box Type B: For slab on grade: single-gang, rectangular, watertight, Class 1, fully adjustable, cast iron box. For slab above grade: single-gang, rectangular, concrete-tight, fully adjustable, stamped galvanized steel box. Brass cover plate and brass carpet ring. Provide aluminum cover plate and trim in lieu of brass when directed by Architect. Provide shallow boxes where necessitated by slab depth.

<table>
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<th>MFR</th>
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<td>829CK-3/4</td>
<td>817C, 817T (for tile)</td>
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4. Box Type C: For slab on grade: two-gang, rectangular, watertight, Class 1, fully adjustable, cast iron box with removable partition. For slab above grade: two-gang, rectangular, concrete-tight, fully adjustable, stamped galvanized steel box. Brass cover plate and brass
carpet ring. Provide aluminum cover plate and trim in lieu of brass when directed by Architect. Provide shallow boxes where necessitated by slab depth.

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<th>MFR</th>
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5. Box Type D: For slab on grade: three-gang, rectangular, watertight, Class 1, fully adjustable, cast iron box with removable partition. For slab above grade: three-gang, rectangular, concrete-tight, fully adjustable, stamped galvanized steel box. Brass cover plate and brass carpet ring. Provide aluminum cover plate and trim in lieu of brass when directed by Architect. Provide shallow boxes where necessitated by slab depth.

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<thead>
<tr>
<th>MFR</th>
<th>CAST IRON BOX</th>
<th>STAMPED STEEL BOX</th>
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<th>COVER PLATE (TEL/DATA)</th>
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6. For Multi-service Floor Boxes, see Division 26/27 Section “Common Work Results for Communications”.

E. Fire-Rated Poke-Through Outlets – TYPE A Single Service

1. UL listed and UL Fire Classified, flush type as indicated on the Drawings, with one- to four-hour fire rating, as required by floor rating and type.

2. Flush type:
   a. Single-service type: Capable of supporting, at a minimum, a duplex 20A/125V receptacle (or equivalent).
   b. Furniture-feed type: Single-service type as indicated on the Drawings.
   c. Cover plate, with individual device covers, and carpet, wood, tile and/or terrazzo floor flange, UL514A listed for scrub water exclusion.
   d. Color: As indicated on Drawings or as directed by the Architect.

3. For additional poke-through types, see Division 26/27 Section “Common Work Results for Communications”.

F. Cabinets and Enclosures
1. General:
   a. Compliance: NEMA 250; UL 50 and 508A, as applicable.
   b. NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; manufacturer's standard ANSI 61 gray polyester powder finish inside and out; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.
   c. NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; manufacturer's standard ANSI 61 gray polyester powder finish inside and out; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.
   d. NEMA Type 4X: External wall-mounting brackets; rolled flanges on door and door opening; continuous-hinged door, with removable stainless steel pin; seamless continuous gasket; stainless steel hasp and staple for padlocking; collar studs; captive, stainless steel door clamps on 3 sides of door; interior data pocket:
      1) Metal: Code-gauge Type 304 stainless steel with continuously welded seams.
      2) Nonmetallic: Fiberglass-reinforced Plastic (FRP) with continuously sealed seams; finished inside with radio-frequency-resistant paint.
   e. Removable painted steel interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.
   f. Where keyed locks are indicated, provide 2 keys for each enclosure, with all locks keyed alike.
   g. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.
   h. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring.
   i. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.4 FACTORY FINISHES

A. Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled metal wireway and surface raceways, enclosures, and cabinets before shipping.
PART 3 - EXECUTION

3.1 RACEWAYS

A. General

1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.

2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).

3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.

4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.

5. Install grounding bushings on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.

6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Architect, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.

7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

8. 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.

9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

10. Install raceways:

a. To meet the requirements of the structure and the requirements of all other Work on the Project.

b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.

c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.

d. Parallel or perpendicular to building lines or column lines.
e. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

11. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.
   a. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   b. Space raceways laterally to prevent voids in concrete.
   c. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   d. Change from RNC to coated GRS or IMC before rising above the floor.

12. Where masonry walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.

13. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section “Hangers and Supports for Electrical Systems”. Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.

14. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:
   a. Attach single raceway directly to structural steel with beam clamps.
   b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.
   c. Attach groups of raceway to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
   d. Attach groups of raceway to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.
   e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.
   f. Hang horizontally suspended groups of raceway using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and
to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.

g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.

h. Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.

15. Install electrically- and physically-continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flakes the finish.

16. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Architect’s approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.

17. Align and install raceway terminations true and plumb.

18. Complete raceway installation before starting conductor installation.

19. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

20. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.

21. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

22. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

   a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.

   b. Where otherwise required by NFPA 70.

23. 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 finished floor. Extend conductors to equipment with GRS; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

B. RMC
1. Use GRS or IMC in the following areas:
   a. Where indicated.
   b. Exterior applications where above grade and exposed.
   c. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.
   d. All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.

2. Use RAC in the following areas:
   a. Indoors above grade.
   b. Interior wet or damp locations.
   c. For circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

3. Do not use RAC:
   a. Below grade.
   b. Imbedded in concrete or other areas corrosive to RAC.

C. EMT

1. Use EMT in the following areas:
   a. Where indicated.
   b. Interior concealed locations for:
      1) Branch and feeder circuits.
      2) Low-voltage control, security, and fire alarm circuits

2. Do not use EMT:
   a. Below grade.
   b. In exterior applications when exposed.

D. FMC and LFMC

1. Use FMC or LFMC:
   a. For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
b. From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.

2. Do not use FMC or LFMC:
   a. For branch circuits, homeruns or feeders.
   b. In lengths exceeding 6 feet.

3. Use FMC only in dry locations; use LFMC in damp, wet, corrosive, and outdoor locations.

E. RNC

1. Solvent-weld RNC fittings and raceway couplings per the manufacturer’s instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.

2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per Article 352.44 of NFPA 70, to accommodate thermal expansion in straight runs.

3. Use RNC in the following locations:
   a. Only where specifically indicated, and then only as specified below.
   b. Underground, single and grouped, in lieu of GRS or IMC, when indicated.
      1) Direct buried
      2) Concrete-encased (use approved rigid PVC interlocking spacers, selected to provide minimum duct spacing and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts).

4. Do not use RNC:
   a. Exposed indoors
   b. In occupied spaces.
   c. In return air plenums.
   d. Where subject to physical damage.
   e. Where not permitted by codes.

F. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in
PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.

3. Join raceways with fittings designed and approved for that purpose and make joints tight.

4. Use insulating bushings to protect conductors at raceway terminations:
   
a. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

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

G. Telephone and Signal/Data System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

H. Wireways
   
1. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.

2. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

3. Close ends of wireway and unused raceway openings.

3.2 BOXES

A. General
   
1. Verify locations of device boxes prior to rough in.

2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.

3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.

4. Install boxes to preserve fire ratings of walls, floors, and ceilings.

5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.


7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
8. Adjust flush-mounted boxes to make front edges flush with finished wall material.

9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.

10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.

B. Outlet Boxes

1. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes.

2. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Architect. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.

3. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.

4. Install extension and plaster rings as required by NFPA 70.

5. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.

6. Do not exceed allowable fill per NFPA 70.

7. Where multiple devices are shown grouped together, gang mount with a common cover plate.

C. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.

2. Provide boxes set flush in painted walls or ceilings with primer coated cover.

3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.

4. Boxes for exterior use shall be:
   a. Cast aluminum with a cast aluminum cover sealed and gasketed watertight.
b. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.

c. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

D. Floor Boxes

1. Use cast or non-metallic floor boxes for installations in slab on grade. Unless otherwise indicated, formed steel boxes are acceptable for slabs above grade.

2. Set metal floor boxes level and flush with finished floor surface.

3.3 CABINETS AND ENCLOSURES

A. Unless otherwise indicated on the Drawings, provide NEMA 1 construction for indoor, dry locations; NEMA 12 for indoor, damp and dusty locations; NEMA 3R for outdoor locations; NEMA 4X for indoor wet and corrosive locations.

B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.

C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.

D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.

E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.

F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

END OF SECTION
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Nameplates
2. Labels for raceways and metal-clad cable.
3. Labels for junction boxes and pull boxes.
4. Labels for wiring devices and lighting control devices.
5. Markers for conductors, and control cables.
6. Tags.
7. Warning labels and signs.
9. Instruction signs.
10. Miscellaneous identification products.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.


C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

D. Coordinate installation of identifying devices with location of access panels and doors.

E. Install identifying devices before installing acoustical ceilings and similar concealment.
1.3 SUBMITTALS
A. Product Data: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements” for each electrical identification product indicated:

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories:
   1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.
   2. Marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL
A. Location, text, and method of identification to be used is noted in individual sections. Refer to related sections for additional identification requirements.

2.2 NAMEPLATES
A. Engraved, Laminated Acrylic or Melamine Label, adhesive backed. Unless otherwise indicated, provide a single line of text with 1/2-inch (13-mm) high letters on 1-1/2-inch (38-mm) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.
   1. Normal systems - white letters on a black background.
   2. Emergency systems - white letters on a red background

2.3 LABELS FOR RACEWAYS AND METAL-CLAD CABLE
A. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.4 LABELS FOR JUNCTION BOXES AND PULL BOXES

A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.5 LABELS FOR WIRING DEVICES

A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

B. Engraved, Laminated Acrylic or Melamine Label: adhesive backed. Minimum letter height shall be 3/16 inch (4.76 mm).
   1. Normal systems - white letters on a black background.
   2. Emergency systems - white letters on a red background

C. Engraved cover plates: Provide with white letters. White or ivory cover plates shall have black letters.

2.6 MARKERS FOR CONDUCTOR AND CONTROL CABLES

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

2.7 TAGS

A. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.8 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.
B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

3. Workspace Clearance Warning (480 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (915 MM)."

2.9 ARC FLASH WARNING LABELS

A. 3.5 in. x 5 in., unless otherwise noted by Owner, 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 printed after the results of the analysis have been presented 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. Available fault current
4. Flash protection boundary
5. Hazard risk category
6. Incident energy
7. Working distance
8. Engineering report number, revision number and issue date.

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

2.10 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters.

1. Punched or drilled for mechanical fasteners.
2. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
3. Normal systems: Engraved legend with white letters on black face.
4. Essential Systems: Engraved legend with white letters on red face.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

B. Fasteners for Nameplates, Labels and Signs

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

2.12 PAINTED IDENTIFICATION

A. Paint materials and application requirements are specified in Division 09 painting Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify identity of each item before installing identification products.

B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

C. Painted Identification: Prepare surface and apply paint according to Division 09 painting sections.
3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. For surfaces that require finish work, apply identification devices after completing finish work.

C. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

D. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

F. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual

END OF SECTION
SECTION 260573 - OVERCURRENT DEVICE COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices.

1. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the fault current study. Device ratings for furnished equipment shall be as required by the results of the fault current study at no additional cost.

B. Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 26 Section “General Electrical Requirements” for general requirements and related documents that apply to this section.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:

1. Coordination-study input data, including completed computer program input data sheets.

2. Coordination-study report.

3. Equipment evaluation report.

4. Arc-Flash Hazard Analysis.

5. Setting report.

E. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section “General Electrical Requirements”:

1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.
1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 399 for general study procedures.

D. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard calculations.

PART 2 - PRODUCTS AND MATERIALS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:

   1. CYME International, Inc.
   2. EDSA Micro Corporation.
   3. Electrical Systems Analysis, Inc.
   4. SKM Systems Analysis, Inc.
   5. Operation Technology, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

   1. Zero-Sequence current.
   2. Arcing faults.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

C. Fault current study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.

D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project’s utility company confirms the available fault current. A final coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity. For the components of emergency and legally required standby system components, full selectivity must be maintained.

3.2 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths on both sides of any transfer switch, contactor or circuit breaker.

B. Components include, but are not limited to:
   1. Switchgear
   2. Switchboards
   3. Distribution Panelboards
   4. Panelboards

3.3 POWER SYSTEM DATA FOR STUDIES

A. Gather and tabulate the following input data to support studies:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical distribution system diagram showing the following:
a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
b. Circuit-breaker and fuse-current ratings and types.
c. Relays and associated power and current transformer ratings and ratios.
d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
e. Generator kilovolt amperes, size, voltage, and source impedance.
f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
g. Busway ampacity and impedance.
h. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Magnetic inrush current overload capabilities of transformers.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Ratings, types, and settings of utility company's overcurrent protective devices.
   e. Special overcurrent protective device settings or types stipulated by utility company.
   f. Time-current-characteristic curves of devices indicated to be coordinated.
   g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
   h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   i. Panelboards, switchboards, motor-control center ampacity, and interrupting ratings in amperes rms symmetrical.

3.4 FAULT-CURRENT STUDY

A. Source Impedance: University's electrical network's fault-current contribution as indicated.
B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
   2. Low-Voltage Fuses: IEEE C37.46.

F. Study Report:
   1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
   2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
   3. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

G. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.5 COORDINATION STUDY

A. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

E. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve the level of selective coordination required in the contract documents or by the edition of the National Electrical Code (including any local jurisdiction amendments) the project must comply with. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices.
4. For emergency, legally required standby and health care essential power systems, such systems must selectively coordinate to the values indicated below unless local amendments to the National Electrical Code require a different value.
   
a. Emergency (NEC article 700) 0.01 seconds

3.6 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment.

   1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
      
a. Verify that overcurrent protective devices meet parameters used in studies.

      b. Adjust devices to values listed in study results.

      c. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.7 ARC-FLASH HAZARD ANALYSIS

A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies. Perform the analysis under worst-case arc-flash conditions for all modes of operation.

B. Identify all locations and equipment to be included in the arc-flash hazard analysis:

   1. Include a copy of the facility one-line in the report.

   2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.

   3. Calculate the arcing fault current flowing through each branch for each fault location.

   4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.

   5. Select the working distances based on system voltage and equipment class.

   6. Calculate the incident energy at each fault location at the prescribed working distance.

   7. Determine the hazard/risk category (HRC) for the estimated incident energy.

   8. Calculate the flash protection boundary at each fault location.


   10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.
C. Results of the arc-flash study shall be summarized in a final report containing the following:

1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.

2. Tabulations of the data used to model the system components and a corresponding one-line diagram.

3. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment ratings.

4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.

5. Required arc-flash labeling and placement of labels.

6. Conclusions and recommendations.

END OF SECTION
SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following lighting control devices:
   1. Stand-Alone Low-voltage occupancy sensors.
   2. Stand-Alone Low-voltage power packs.
   3. Stand-Alone Low-voltage switches.
   4. Automatic load control relays.
   5. Conductors and Cables for Lighting Control Devices.

1.2 DEFINITIONS

A. Closed loop: Photosensor control algorithm designed for influence by both daylight and electric light in a space or area.

B. DPDT: Double pole, double throw.

C. DPST: Double pole, single throw.

D. LED: Light-emitting diode.

E. Open loop: Photosensor control algorithm designed for influence by daylight entering in a space or area.

F. PIR: Passive infrared.

G. SPST: Single pole, single throw.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.4 SUBMITTALS

A. Product data for the following products:
   1. Catalog cut sheets, including major and minor motion coverage patterns sensors, time delay and sensitivity adjustability settings, load restrictions, and performance specification items indicating compliance with this specification for all lighting control devices.
B. Shop Drawings:

1. Occupancy sensors
   a. Show installation details.
   b. Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.
   c. Interconnection diagrams showing field-installed wiring.
   d. Include diagrams for power, signal, and control wiring.
   e. For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:
      1) Factory-generated occupancy sensor layouts on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.
      2) List of any deviations to this specification or Basis of Design products.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Occupancy sensors:
   a. Manufacturer’s installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.
   b. Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.
   c. Manufacturer’s maintenance, including operating and adjustment instructions.

1.5 QUALITY ASSURANCE

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

B. Occupancy sensors

1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.

2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.
3. Manufacturer shall test all equipment prior to shipment.

1.6 WARRANTY

A. Manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 STAND-ALONE LOW-VOLTAGE OCCUPANCY/VACANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

1. Occupancy sensors and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.

2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. UL Listed for dry locations and complies with local codes.

4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.

a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.

b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of a separate, associated switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.

5. Switch Rating: As indicated in Lighting Control Device Schedule.

6. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.

7. Mounting: Suitable for mounting in any position on a standard outlet box.

8. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

9. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.

10. Bypass Switch: Override the “on” function in case of sensor failure, concealed on unit to prevent tampering.

11. Finish: Sensor finish shall be white.
12. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

13. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.

14. Sensors:
   a. Sensor shall be compatible with lighting control system.
   b. Sensors shall be capable of being combined with additional sensors to achieve adequate coverage.
   c. Sensor coverage pattern: AS indicated on Lighting Control Device Schedule, and shall have been confirmed with Nema WD7 Guide and Robotic test method.
   d. Detection types: Provide type or types indicated in Lighting Control Device Schedule.
      1) PIR Type: Detect occupancy by sensing a combination of infrared heat and movement.
         a) Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
         b) Sensor shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
         c) Sensor shall provide high immunity to false triggering from RFI and EMI.
         d) Sensor shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.
      2) Ultrasonic Type: Detect occupancy by sensing a change in pattern of reflected ultrasonic energy.
         a) Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
         b) Detection Frequency (Small Area – 500 sq ft and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHZ within +/-0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.
c) Detection Frequency (Medium and Large Areas – greater than 500 sq ft): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.

d) Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.

3) Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

a) Sensitivity Adjustment: Separate for each sensing technology.

b) Different LED indicator colors for each sensing technology.

c) PIR sensor component shall comply with all requirements listed under PIR Type under General Requirements for Sensors under Stand-Alone Line-Voltage Occupancy Sensors.

d) Ultrasonic sensor component shall comply with all requirements listed under Ultrasonic Type under General Requirements for Sensors under Stand-Alone Line-Voltage Occupancy Sensors.

2.2 STAND-ALONE LOW-VOLTAGE POWER PACKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

1. Power packs and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.

2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. UL Listed for dry locations and complies with local codes.

4. Unit shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings

5. Relay shall be compatible with the specific lighting types controlled.

6. Operations: Refer to drawings for Sequence of Operations or other operational instructions. Unit operates in conjunction with other system components. Refer to operations requirements of associated devices.

7. Switch Rating: As indicated in Lighting Control Device Schedule.
Mounting: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.

8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.3 STAND-ALONE LOW-VOLTAGE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.

2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. UL Listed for dry locations and complies with local codes.

4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Manual push of any button shall energize or de-energize loads.

5. Mounting: Suitable for mounting in any position on a standard outlet box.

6. Indicator: LED, for each button to indicate when loads are energized and de-energized.

7. Finish: Sensor finish shall be as directed by the Architect.

8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.4 AUTOMATIC LOAD CONTROL RELAYS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. For control of emergency lighting circuits: Loss of normal power shall cause relay to automatically shunt emergency power to lighting circuit regardless of manual or automatic switch position. Emergency lighting circuit shall continue to operate at full power until normal power has been restored.

2. Coil Rating: 120 or 277 V, as indicated on Drawings.
3. Mounting: Either a 2-gang outlet box with separation barrier and plaster ring or a wall-mountable box with separate compartments. Mount per manufacturer’s instructions.

4. Auxiliary Relay input: Provisions to shunt emergency lighting on upon receiving a signal from an outside system such as security or fire alarm system.

2.5 CONDUCTORS AND CABLES FOR LIGHTING CONTROL DEVICES

A. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.

B. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG.

C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.

D. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG.

E. Provide all necessary conductor and cabling required for operation of the controls and control systems specified. This includes power and control wiring required for the controls to operate as described.

PART 3 - EXECUTION

3.1 INSTALLATION

A. GENERAL

1. Install devices and associated power packs and wiring in accordance with manufacturer’s instructions and applicable codes.

B. OCCUPANCY/VACANCY SENSORS

1. Arrange a pre-installation meeting with manufacturer’s factory authorized field representative, at Owner’s facility, to verify placement of sensors and installation criteria.

2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.

3. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems and partition assemblies.

4. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from the nearest edge of air supply devices or similar obstructions that would adversely affect the sensor performance.
5. Adjust time delay setting of occupancy sensors to de-energize loads after space has been unoccupied for period of time indicated on the Drawings.

6. Install devices and auxiliary equipment in compliance with manufacturer's instructions and recommendations.

7. Install relay units where concealed from view and where accessible.

8. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

9. Install switchbox mounted occupancy sensors at same elevation as other lighting control switches.

C. AUTOMATIC LOAD CONTROL RELAYS

1. When used with manual controls, install emergency shunt relay in accessible ceiling near the control device or wall mounted within electrical room. Label within enclosure the connected normal and emergency circuits.

2. When used with automatic controls, install where concealed from view in accessible ceiling near the automatic control device or wall mounted within electrical room. Label outlet box cover with connected normal and emergency circuits.

D. WIRING

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."

B. Power and control wiring: Identify using marker tapes.

1. Identify circuits or luminaries controlled by occupancy sensors at each sensor.

C. Components: Label each component with self-laminating computer printed labels, using a unique designation matching control drawing.
D. Cover plates: Refer to drawings for labeling requirements of certain cover plates for manual switches, or similar devices, requiring labeling for user information.

E. Buttons/switches:
   1. Engraved from manufacturer. Refer to drawings for detailed requirements and text for labeling.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
   2. Operational Test: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer’s instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer’s installation instructions for each sensor model.

B. Lighting control devices that fail tests and inspections are defective work. Remove, replace, and retest devices that fail tests.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section “Lighting Control Systems.”

END OF SECTION
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SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1500 kVA:

   1. Distribution transformers.

1.2 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, technical certification sheets and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


   2. Transformer ratings including:

      a. kVA

      b. Primary and secondary voltage

      c. Taps

      d. Basic impulse level (BIL) for equipment over 600 volts

      e. Design impedance

      f. Insulation class and temperature rise

      g. Sound level.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.
1.3 QUALITY ASSURANCE

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

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

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

E. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

F. All transformers shall be UL listed and bear the UL label.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:


2. ACME Electric Corporation; Power Distribution Products Division
5. Hammond Company
6. Sola/Hevi-Duty
7. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: One leg per phase. Cores shall be constructed of high grade, non-aging silicon steel. The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor or strap sized in accordance with UL and NEC requirements. The neutral shall be brought to a stud to facilitate the required external grounding of the secondary

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper.

D. Connections to transformers shall be by flexible metal conduit and using flexible couplings.

E. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

F. Wiring/Terminations:
   1. Recommended external cable shall be rated 90 degrees C (sized at 75 degrees C ampacity) for encapsulated and 75 degrees C for ventilated designs.
   2. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.
   3. Lug kits shall be provided by the Manufacturer of the transformer.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Enclosures: Unless otherwise specified, transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. Enclosures shall have a baked polyester powder coat finish-gray in color and suitable for interior or exterior applications. Enclosures shall
be constructed so that there are no exposed live parts. Enclosures shall have a removable front cover to allow access to internal parts and wiring terminations

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

2. Transformer locations:
   a. Dry locations:
      1) Ventilated
      2) NEMA 250, Type 2.

3. The maximum temperature of the enclosure shall not exceed 90 degrees C.

4. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

C. Taps for Three-phase Transformers smaller than 24 kVA and all single phase transformers: One 5 percent tap above and one 5 percent tap below normal full capacity.

D. Taps for Transformers 25 kVA through 500 kVA: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

E. Taps for Transformers 501 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class for transformers less than 15 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

G. Insulation Class for transformers 15 kVA and larger: 220 deg C, UL-component-recognized insulation system with a maximum of [150] [115] [80] deg C rise above 40 deg C ambient temperature.

H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment" efficiency levels.
   2. Tested in accordance with federal law 10 CFR Part 431.

I. Mounting Methods.
   1. Transformers 75 KVA and larger shall be floor mounted unless indicated otherwise. Transformers 45 KVA and smaller may be wall mounted where wall construction is suitable for the load. Floor mounted transformers shall be securely bolted to a 4 inch house keeping pad with vibration isolation pads. Wall mounted or suspended transformers shall have a means of isolating vibration from the support.
2. Transformers up through 1000 KVA shall be mounted on elastomeric vibration isolation pads. Pad shall be constructed of neoprene, rubber, glass fiber, or a combination thereof. Pads shall be “ribbed” or “waffled” in texture. Pads shall be selected for smallest durometer (hardness), preferably less than 50. Deflection of pad shall be .25” static minimum. Stack pads until the desired deflection is achieved.

3. Wall Mounting: Manufacturer's standard brackets.

4. Suspended Mounting: See transformer mounting detail on plans.

J. Low-Sound-Level Requirements: Maximum sound levels (NEMA ST 20), when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40 dBA
2. 30 to 50 kVA: 45 dBA
3. 51 to 150 kVA: 50 dBA
4. 151 to 300 kVA: 55 dBA
5. 301 to 500 kVA: 60 dBA
6. 501 to 700 kVA: 62 dBA
7. 701 to 1000 kVA: 64 dBA
8. 1001 to 1500 kVA: 65 dBA

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to ANSI C57.12.01 and IEEE C57.12.91.

2.6 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. Ratio tests at the rated voltage connection and at all tap connections
2. Polarity and phase relation tests on the rated voltage connection
3. Applied potential tests
4. Induced potential test
5. No-load and excitation current at rated voltage on the rated voltage connection

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Use flexible conduit under the provisions of Division 26 Section "Raceways and Boxes for Electrical Systems" for connections to transformer case. Minimum flexible conduit length shall be two (2) feet.

B. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.
D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed “Satisfactory Test” label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.


3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION
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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Distribution panelboards.
B. Lighting and appliance branch-circuit panelboards.
C. Disconnecting and Overcurrent Protective Devices.
D. Accessory Components and Features.

1.2 DEFINITIONS

A. SVR: Suppressed voltage rating.
B. SPD: Surge Protection Device

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and 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. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit electronic files, in an SKM-compatible format.

C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Overcurrent Protective Device Coordination Study”

D. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: Submit final panelboard directories.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:

1. Routine maintenance requirements for panelboards and all installed components.

2. Manufacturer’s written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

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

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.
1.6 DELIVERY, STORAGE, AND HANDLING
   A. Remove loose packing and flammable materials from inside panelboards.
   B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 FIELD CONDITIONS
   A. Environmental Limitations:
      1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in
         spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is
         operating and maintaining ambient temperature and humidity conditions at occupancy levels during
         the remainder of the construction period.
      2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
         a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
   B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
      1. Ambient temperatures within limits specified.
      2. Altitude not exceeding 6600 feet (2000 m).
   C. Interruption of Existing Electric Service: Do not interrupt electric service to occupied facilities. Refer
      to Division 26 Section “General Electrical Requirements” for allowable outages.

1.8 WARRANTY
   A. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following to
      match existing conditions:
      1. Square D; a brand of Schneider Electric.
   B. Enclosures: Flush- or surface-mounted cabinets as noted.
      1. Rated for environmental conditions at installed location.
         a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Hinged Front Cover: Entire front trim hinged to box.

3. Door: Standard door with concealed hinges, within hinged trim cover. Secured with vault-type latch with tumbler lock; keyed alike.

4. Finishes:
   a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.


C. Incoming Mains Location: Top and/or bottom as required.

D. Buses: Three phase, four wire unless otherwise indicated.
   1. Phase, and Neutral Buses:
      a. Material:
         1) Hard-drawn copper, 98 percent conductivity.
      b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard's sections.
         1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

   2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
      a. Material: Hard-drawn copper, 98 percent conductivity
      b. Size: Minimum-size required by UL 67

E. Line-Side Conductor Connectors (Lugs):
   1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.
   2. Material: Same as bus material.
   3. Capacity rating: Same as associated bus.
   4. Type: Provide mechanical type unless otherwise indicated on Drawings, refer to schedules and one-line diagram.
F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.


2.2 DISTRIBUTION PANELBOARDS

A. See manufacturers above.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: As indicated on drawings.

E. Branch Overcurrent Protective Devices:

1. Connection to bus:
   b. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2. Type: Provide types as indicated on drawings and as defined below.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. See manufacturers above.

B. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated on drawings.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. See manufacturers above.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.


2. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical type unless otherwise indicated on Drawings, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      1) Mounting: Integral
   e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
   h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
   i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
   j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
   k. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
   l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
   m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Mount top of trim 72 inches (1788 mm) above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."

B. Panelboard Nameplates: Label each panelboard with a nameplate.

C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate.

D. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.
   1. Exception: Do not install NFPA 70 working clearance requirements on flush panelboards and similar equipment in finished spaces.

E. Identify field-installed conductors, interconnecting wiring, and components; complying with Division 26 Section "Identification for Electrical Systems."

F. Panel Directories
1. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

2. Noted the date the directory was created/updated.

3. Create directory after loads have been balanced.

4. Replace existing directories with revised type written directories indicating changes.

3.4 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:
1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION
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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles: Single, duplex, USB/duplex, USB-only, twist-lock, ground-fault circuit interrupters (GFCI), surge protective device (SPD), isolated ground (IG) and tamper resistant (TR).


3. Device Wall Plates.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. IG: Isolated Ground

C. PIR: Passive Infrared.

D. RFI: Radio Frequency Interference

E. SPD: Surge Protective Device

F. USB: Universal Serial Bus

G. TR: Tamper Resistant

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product data for the following products:

1. Provide manufacturer’s catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, AC wall switches, and cover plates.

C. Field quality-control test reports.

D. Warranty: Special warranties specified in this Section.
### QUALITY ASSURANCE

A. **Source Limitations:** Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.

B. **Materials** shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.

C. **Electrical Components, Devices, and Accessories:**
   1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
   2. Marked for intended use.

D. Comply with NFPA 70.

### COORDINATION

A. **Receptacles for Equipment Furnished by Owner or Under Other Divisions or Contracts:** Match plug configurations.

---

### PART 2 - PRODUCTS AND MATERIALS

#### GENERAL

A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

#### MANUFACTURERS

A. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   1. Receptacles and Switches:
      a. Cooper Wiring Devices.
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Mfg. Company Inc.
      d. Pass & Seymour/Legrand; Wiring Devices Div.

B. In other Part 2 articles below, where lists of manufacturers and device catalog numbers are included, the following additional requirements apply to product selection:
1. Additional Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers listed in individual articles below, in addition to those listed in Paragraph “Available Manufacturers” above.

2.3 FINISHES

A. Color:
   1. Wiring devices connected to normal power systems: As selected by Architect, unless otherwise indicated or required by NFPA 70. Cover plates: As selected by the Architect, shall match wall paint color onto which they are mounted.

B. Manufacturer’s model numbers listed are to establish the quality of the wiring devices. Coordinate the proper suffixes in order to provide the correct color as specified above.

2.4 CONVENIENCE RECEPTACLES:

A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A.

B. Duplex convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Duplex</th>
<th>Single</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooper</td>
<td>5362</td>
<td>5351</td>
</tr>
<tr>
<td>Hubbell</td>
<td>5352A</td>
<td>HBL5361</td>
</tr>
<tr>
<td>Leviton</td>
<td>5352</td>
<td>5261</td>
</tr>
<tr>
<td>Pass &amp; Seymour</td>
<td>5362</td>
<td>5361</td>
</tr>
</tbody>
</table>

C. Duplex tamper resistant convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Duplex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooper</td>
<td>TR5362</td>
</tr>
<tr>
<td>Hubbell</td>
<td>HBL8300SGA</td>
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<tr>
<td>Leviton</td>
<td>8300-SGG</td>
</tr>
<tr>
<td>Pass &amp; Seymour</td>
<td>TR5362</td>
</tr>
</tbody>
</table>

D. Duplex weather resistant convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Duplex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooper</td>
<td>TWR270</td>
</tr>
</tbody>
</table>
Hubbell 5362WR
Leviton WBR20
Pass & Seymour WR5862

E. Twist-Locking type receptacles: NEMA L5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, self-grounding.
   Manufacturer Single
   Cooper L520R
   Hubbell HBL2310
   Leviton 2310
   Pass & Seymour L520-R

F. USB/duplex convenience receptacles: NEMA 5-20R, 125V, 20A, tamper resistant, 3-wire, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding; with integral USB charger having two ports, USB 2.0 compatible, 5VDC, 3A output (min).
   Manufacturer Single
   Cooper TR7756
   Hubbell USB20X2
   Leviton T5832
   Pass & Seymour TR5362USB

G. USB-charging-only convenience receptacles: 125V, 20A, 3-wire, grounding type, UL 1310 listed and labeled, smooth nylon face, side and back wired, self-grounding; with integral USB charger having four ports, USB 2.0 and 3.0 compatible, 5VDC, 4.2A output (min).
   Manufacturer Single
   Cooper 7750
   Hubbell USB4
   Leviton USB4P
   Pass & Seymour TM8USB4

H. Automatically Controlled receptacles: Where indicated on drawings, provide device type from other applicable category, along with marking for controlled receptacles as required by the current version of the NEC. In the case where the NEC is not applicable to the project, the device shall still be provided with this marking. In that case, the NEC is providing the standard for the marking and this specification is requiring it to be marked above and beyond the application of the code.

WIRING DEVICES 262726-4
2.5 GFCI RECEPTACLES

A. Ground fault circuit interrupter type receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Specification Grade</th>
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<tr>
<td>Cooper</td>
<td>VGF2</td>
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<tr>
<td>Hubbell</td>
<td>GF20LA</td>
</tr>
<tr>
<td>Leviton</td>
<td>T7899-H</td>
</tr>
<tr>
<td>Pass &amp; Seymour</td>
<td>2095</td>
</tr>
</tbody>
</table>

B. Ground fault circuit interrupter type weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Specification Grade</th>
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<tr>
<td>Cooper</td>
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<td>Hubbell</td>
<td>GFTR20</td>
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<tr>
<td>Leviton</td>
<td>W7899</td>
</tr>
<tr>
<td>Pass &amp; Seymour</td>
<td>2095TRWR</td>
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</tbody>
</table>

C. Ground fault circuit interrupter type tamper and weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

<table>
<thead>
<tr>
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<tr>
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<td>Leviton</td>
<td>W7899-T</td>
</tr>
<tr>
<td>Pass &amp; Seymour</td>
<td>2095TRWR</td>
</tr>
</tbody>
</table>

D. Ground fault circuit interrupter with Blank Face: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.
2.6 SPECIAL/MISCELLANEOUS DEVICES

A. Special purpose receptacles: Grounding type, UL listed with NEMA configurations as indicated below or on the Drawings.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Dryer 14-30R</th>
<th>Range 14-50R</th>
<th>Switch/Receptacle</th>
<th>Clock 5-15R</th>
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<tbody>
<tr>
<td>Cooper</td>
<td>1257</td>
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<td>Hubbell</td>
<td>HBL9430A</td>
<td>HBL9360</td>
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<td>HBL5235</td>
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<td>278</td>
<td>279</td>
<td>5225</td>
<td>5261-CH</td>
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<tr>
<td>Pass &amp; Seymour</td>
<td>3864</td>
<td>3849</td>
<td>671</td>
<td>S3733</td>
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</tbody>
</table>

2.7 SWITCHES

A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.

B. Switches: Heavy Duty Specification grade, rated for 120/277V, 20A, back and side wired, and UL listed and labeled.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>1 Pole</th>
<th>2 Pole</th>
<th>3 Way</th>
<th>4 Way</th>
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</thead>
<tbody>
<tr>
<td>Cooper</td>
<td>AH1221</td>
<td>AH2221</td>
<td>AH3221</td>
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<tr>
<td>Pass &amp; Seymour</td>
<td>CSB20AC1</td>
<td>CSB20AC2</td>
<td>CSB20AC3</td>
<td>CSB20AC4</td>
</tr>
</tbody>
</table>

2.8 COVER PLATES

A. Damp Location Weatherproof Receptacle Cover Plates: UL-listed Wet Location (cover closed, not in use); die-cast, gasketed (factory-installed) self-closing covers, for horizontal or vertical mounting as indicated:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Horizontal</th>
<th>Vertical</th>
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</table>
A. **Wet Location Weatherproof Receptacle Cover Plates (Outlet Box Hood):** NEMA 3R weather resistant recessed or flush mount, die cast aluminum lockable cover. Configure cover for horizontal mounting of receptacle or as indicated otherwise. Back box must be suitable for conduit connections. Coordinate back box with wall depth.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Horizontal</th>
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<tbody>
<tr>
<td>Thomas &amp; Betts</td>
<td>CKMU</td>
</tr>
<tr>
<td>Eaton</td>
<td>WIUMV-1</td>
</tr>
<tr>
<td>Hubbell</td>
<td>WP26MH</td>
</tr>
<tr>
<td>Leviton</td>
<td>IUM1H-GY</td>
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</table>

B. **Damp and Wet Location Weatherproof switch cover plates:** Fabricated of cast aluminum or cast zinc, sealed water-tight and UL listed for wet locations.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>1 Gang</th>
<th>2 Gang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appleton</td>
<td>FSK</td>
<td>--</td>
</tr>
<tr>
<td>Raco</td>
<td>5100 Series</td>
<td>--</td>
</tr>
<tr>
<td>Steel City</td>
<td>SW Series</td>
<td>--</td>
</tr>
</tbody>
</table>

C. **Other locations:** Single and combination types to match corresponding wiring devices and manufacturer of wiring devices specified herein.

1. **Plate securing screws:** Metal with head color to match finish plate.
2. **Material for Finished Spaces:** Brushed stainless steel Type 302.
3. **Material for Unfinished Spaces and surface mounted wiring devices:** Galvanized steel.
4. **Masonry walls and oversized wall openings:** Jumbo size plates with same material as indicated above.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.

C. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.

E. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.

F. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.

G. Install switches with OFF position down.

H. Install cover plates on all switches, receptacles, and blank outlets.

I. Locate wiring devices so that the cover plate does not have to be cut to be installed.

J. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.

K. Install cover plates after the wall has been finished (painted, wall paper, etc).

L. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

M. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6’ or sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.

N. Install wiring devices shown back-to-back on a common wall offset a minimum of 12” horizontally to reduce sound transmission between rooms.

3.2 GENERAL

A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Architect.
B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.

C. Provide twist-locking type receptacles or other special type receptacles where indicated on the Drawings.

3.3 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Verify that outlet boxes are installed at proper height and are flush with the finished surface.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that floor boxes are adjusted properly and are flush with the finished surface.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.4 PREPARATION

A. If required, provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from in and around outlet boxes.

3.5 MOUNTING HEIGHTS

A. Coordinate locations of outlet boxes provided under Division 26 Section “Common Work Results for Electrical”.

B. Unless noted otherwise, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.

1. Receptacles:
   a. General:
      1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.
      2) Where installed horizontally, install neutral slot mounted at the top.
   b. Above counters:
      1) Mount vertically.
   c. Mechanical and electrical equipment rooms and janitors closets:
      1) Mount horizontally.
   d. GFCI receptacles: Same as general receptacles.
e. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.

2. Switches:
   a. Above counters: Same as for receptacles.
   b. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.

3. Telephone/Data Outlet Boxes:
   a. General: Match mounting height of adjacent wiring device listed above.

3.6 IDENTIFICATION

A. Label all devices fed down stream of GFCI protected receptacles as “GFCI PROTECTED”.

B. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served, using:
   a. Hot, stamped or engraved machine printing with black-filled lettering on face of plate.
   b. Durable wire markers or tags inside outlet boxes.
   c. Permanent-ink marker, hand-printed legibly, inside outlet boxes.
   d. Adhesive film label, but with letter/number height of 1/4 inch, on face of plate.
   e. Adhesive Film Label with Clear Protective Overlay, but with letter/number height of 1/4 inch, on face of plate, for exterior and damp/wet locations.

3.7 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.

D. Test all wiring devices for electrical continuity and proper polarity of connections.

E. Test each GFCI receptacle device for proper operation.

F. Correct wiring devices incorrectly installed.
G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.8 ADJUSTING
   A. Adjust devices and wall plates to be flush and level.

3.9 CLEANING
   A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION
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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Qualification Data: For qualified testing agency.

C. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer’s field service report.

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

1. Manufacturer’s written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency’s Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

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

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).


B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify University no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without University’s written permission.

4. Comply with NFPA 70E.

1.6 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 EXTRA MATERIALS

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

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.


4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Compression type, suitable for number, size, and conductor material.
6. Accessory Control Power Voltage: Remote mounted and powered; 24-V dc.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.


D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and $I^2t$ response.

F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

H. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.


2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.


4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION
SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:

1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, transformers, drivers and power supplies.

2. Exit signs.

3. Light fixture supports.

4. Coordination.

5. Quality assurances.

6. Specific requirements.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 26 Section "General Electrical Requirements" for general requirements and related documents that apply to this Section.

B. Division 26 Section "Common Work Results for Electrical" for raceways, conductors, cables, and cords.

C. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

D. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

1.3 SUBMITTALS

A. General:

1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.

2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
3. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.

4. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.

5. Modifications to fixtures shall be in accordance with Architect’s comments.

B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Summary page with the following for each light fixture type
   a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
   b. Light fixture driver or auxiliary device manufacturer, number and type.

2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
   a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.
   b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
      1) Include MacAdam ellipse step information for:
         a) All interior light fixtures

3. Light fixture mounting details, including non-standard outlet boxes.

4. Construction of light fixture housing and door (if applicable).

5. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.

6. Light fixture finish and color (if applicable).

7. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
   a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.

8. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in this Project.
a. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

C. Shop Drawings: Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.

D. Submittal Schedule
   1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to architect to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.
   2. Within 15 days of “approved” and “approved as noted” shop drawings, contractor shall forward to Architect a guaranteed ship date for each specified fixture.
   3. Within 15 days after contractor’s receipt of “reject and resubmit” or “not approved” shop drawings, contractor shall provide Architect with resubmitted shop drawings for only those fixtures deemed unacceptable.
   4. Contractor is responsible to call to the attention of the Architect any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.

E. Control Wiring

F. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

G. Qualification Data: For agencies providing photometric data for light fixtures.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.

J. Warranties: Special warranties specified in this Section.

1.4 SUBSTITUTIONS

A. Refer to Division 26 Section “General Electrical Requirements”.

B. Prior to the Bid Date, substitutions will not be considered unless the Architect/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and complete Product Data for the proposed substitute, as defined in SUBMITTALS above, and all other information necessary for an
evaluation. Provide interior point-by-point calculations, under both normal and emergency lighting conditions, as applicable, if required by the Engineer. Submit a $100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.

C. During the Bid

1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.

2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:

3. Agents can group only specified fixtures they represent, and

4. Only represent in the region where the specification originated, and

5. Exclude all fixtures outside their represented lines from the MLP, and

6. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.

7. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.

D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Architect/Engineer.

E. During the construction period, no substitutions shall be considered if product delay is due to contractor's failure to order products in a timely manner after presentation of fixture schedules and specifications. Additional costs associated with air freight or special factory runs to meet schedule due to contractor's error shall be at the expense of contractor.

F. The Architect/Engineer has the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.5 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature

C. CFL: Compact Fluorescent

D. CRI: Color-rendering index.

E. CU: Coefficient of utilization.

G. HID: High-intensity discharge.

H. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs

I. LED: Light Emitting Diode

J. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.

K. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.

L. LER: Light fixture (Luminaire) efficiency rating.

M. Light Fixture: Complete light fixture, including ballast housing if provided.

N. RCR: Room cavity ratio.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

2. Marked for intended use.

B. Comply with NFPA 70.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

D. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.

E. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.

1.7 COORDINATION

A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

B. Coordinate layout and installation of light fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, HVAC equipment,
fire-suppression system, and partition assemblies. Contractor shall arrange his installation in proper relation to other work so that there shall be no interference, damage or delay to other trades' work.

C. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.

D. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.

E. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

1.8 WARRANTY

A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.10.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.

B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.

C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.

1. LED Luminaires, including LED modules, arrays and drivers: Five years.

2. LED Lamps: Three years.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. In Light Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.
2.2 LIGHT FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Provide light fixtures as shown on the drawings and/or specified. This shall include all lamps, material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure to conform to applicable seismic requirements where required.

B. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.

C. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to ceiling system structure. Modifications to standard mounting brackets shall be coordinated with contractor and delivered with fixture so that no delays to product delivery shall be allowed.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

H. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass, unless otherwise indicated.

I. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
J. Fixture Finishes:

1. Apply fixture finishes after fabrication in a manner that assures a durable wear-resistant surfacing. Give exposed metal surfaces (brass, bronze, aluminum and others) and finished castings, except chromium-plated or stainless steel parts, an even coat of high-grade meth/acylate lacquer or transparent epoxy.

2. For corrosive or salt water environments, manufacturer shall provide fixtures with low copper/zinc cast aluminum (AB-47100 aluminum with less than 0.6% copper – classified for corrosive areas) housings to prevent salts from “pitting” aluminum housing. Manufacturer shall provide, in addition to or in lieu of, AB-47100 aluminum, ion added or pre-anodized polyester powder cast finish for “marine grade” applications. Manufacturer shall otherwise provide all stainless steel housing in conjunction with stainless steel hardware.

3. Recessed downlights in corrosive or salt water interior environments shall be equipped with a “natatorium” finish comprised of a zinc-chromated and phosphated process, then powder-coated on the exterior of the housing.

K. Reflectors:

1. Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch (15 gauge) or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish: Alzak” with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from Nadir and semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.

L. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, ballasts and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp, LEDs, ballast and/or driver characteristics:
   
   a. “USE ONLY” and include specific lamp or LED type.

   b. LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.

   c. CCT and CRI for all luminaires.

2.3 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2.4 DRIVERS FOR LED LUMINAIRES

A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Power Factor: 0.90 or higher at full load.
5. Driver shall operate with maximum sustained variations of +/-10% input voltage and frequency with no damage to driver.
6. Driver output shall be regulated to maximum +/- 5% published load range or requirements of downstream LED fixture.
7. LED Current Crest Factor: 1.5 or less.
8. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
10. ROHS Compliant.

B. Dimming Drivers:

1. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
   a. Luminaires: 100 to 10 percent of rated lumens.
   b. Lamps: 100 to 20 percent of rated lumens.
2. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and LED indicated.
4. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.5 LED LAMPS AND LUMINAIRES

A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and 3000K CCT.
B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.

C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:
   1. LED lamps: 20,000 hours
   2. LED luminaires: 50,000 hours

D. ROHS compliant

E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

2.6 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

2.7 LIGHT FIXTURE SUPPORT COMPONENTS

A. Comply with Sections "260548 Seismic Controls for Electrical" and "260529 - Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.


E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.8 TRANSFORMERS FOR LOW VOLTAGE FIXTURES

A. Provide transformers to low voltage lamps which are suitable for the electrical characteristics of the supply circuits to which they are to be connected. For remote electronic or magnetic transformers, contractor shall remote transformers so as to reduce voltage drop. For 25 amp low-voltage linear systems, contractor shall not daisy-chain 25A loaded runs together. Contractor shall provide home-run from end of run to remote transformer.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION

A. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.

2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

D. Suspended Light Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.


3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.

4. Decorative pendant mounted light fixtures

a. Provide cord and/or stem lengths to match elevations above finished floor as indicated on architectural elevations. If architectural elevations do not indicate suspension heights, coordinate with Architect to determine final suspension heights. Regardless, contractor shall not field cut pendants or order rigid stems without elevation approval from Architect. Pendant suspensions on electrical documents are for reference only.

1) Cord-mounted: Manufacturers shall supply luminaires with flexible, field cutting cords. Contractor shall field cut cords as required.
2) Field-cuttable, rigid-stem mounted: Manufacturers shall supply luminaires with field cutting rigid stems. Contractor shall field cut stems as required.

3) Factory-cut rigid stem mounted: Contractor shall provide rigid stem dimensions to the manufacturer as required.

b. Junction boxes used to feed light fixtures shall be covered by manufacturer supplied canopy plates.

E. Installation within non-standard ceilings, including, but not limited to, wood and metal ceilings.

1. For recessed downlight light fixtures, specification is based on standard throats to accommodate ceiling thicknesses of \( \frac{3}{4}'' \) or less. If non-standard ceiling (such as wood, thickened gypboard ceilings and metal plank type) require throats greater than \( \frac{3}{4}'' \), modifications to manufacturer’s standard \( \frac{3}{4}'' \) throat shall be determined by Architect and Contractor prior to shop drawing submission.

2. For light fixtures recessed into metal ceilings, rigidly support light fixture to ensure that trim fits flush with ceiling plane.

F. Connect wiring according to Section “260519 - Low-Voltage Electrical Power Conductors and Cables.”

G. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.

H. Wall Mounted Light fixtures

1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations or dimensions are not indicated, verify the correct location with Architect prior to installation. Contractor shall supply structure to support weight of fixture.

I. Contractor shall construct light coves according to architectural details. Contractor shall ensure, unless otherwise directed, that top of fixture lamp is flush with top of cove lip. Contractor shall provide blocking as needed under fixture to ensure stated requirement.

J. Auxiliary Devices for low voltage and LED Fixtures

1. Install device within maximum remote distances and with wiring sized per manufacturer’s recommendations.

2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.

3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.

4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer’s recommendations.
3.3 DIMMING

A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer’s recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:

1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
2. 2-Wire dimming – two line voltage conductors plus ground
3. 3-Wire dimming – three line voltage conductors (1 for control and two for power) plus ground
4. DALI – two low voltage conductors and two line voltage conductors plus ground
5. Proprietary digitally addressable – as required per the manufacturer
6. DMX – two line voltage conductors plus ground and DMX cabling

B. Coordinate light fixture and control device dimming types for compatibility.

3.4 COORDINATION

A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.

B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.

C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

D. Wall-Mounted Light fixtures

1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Architect prior to beginning any work.

3.5 ADJUSTING

A. Contractor shall adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.

B. At the time of substantial completion, aim all track lights, flood lights, spot lights, and other fixtures requiring aiming per the Architect’s direction. Contractor shall make provisions for supplying all scaffolds, lifts, and other tools and equipment as required.

C. Where required, focusing shall be done during hours of darkness. Upon notification by contractor that all fixtures are correct as per shop drawings and functioning, that specified lamps have been
verified, lighting designer or Architect shall coordinate with contractor as to a mutually agreed
upon time to complete focusing. Failure of contractor to notify Architect during substantial
completion will result in failure to comply with specifications.

3.6 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify
transfer from normal power to battery and retransfer to normal.

B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light
fixtures from damage during the remainder of the construction period.

C. Upon completion of the installation of light fixtures, and after building circuits have been
energized, energize lighting branch circuits to demonstrate capability and compliance with the
requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate
compliance; otherwise, remove and replace with new units, and proceed with retesting.

D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working
order and all light fixtures are fully lamped.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and
interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance
with standards.

3.7 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by
Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least
100 hours at full voltage.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion,
provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions.
Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.
SECTION 270010 - GENERAL COMMUNICATIONS REQUIREMENTS

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 and to all following sections within Division 27.

1.2 DESCRIPTION OF WORK

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system’s functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 27 of these Specifications, and Drawings numbered with prefixes T generally describe these systems, but the scope of the Communications Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers’ requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 ABBREVIATIONS

A. ADA Americans with Disabilities Act
B. AFF Above Finished Floor
C. AHJ Authority Having Jurisdiction
D. ANSI American National Standards Institute
E. ASTM American Society for Testing and Materials
F. BICSI Building Industry Consulting Service International
1.4 QUALITY ASSURANCE

A. Execute all Work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the Work specified.
B. Qualifications – refer to individual Division 27 sections for specific Personnel and Contractor Qualifications.

C. Install all Work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation.

D. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer.

E. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

F. Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations and requirements of the service providers serving the project and the Owner's insurance underwriter.

G. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the most stringent apply.

H. Should any change in drawings or specifications be required to comply with governing regulations, notify and receive written approval from the Architect prior to submitting bid.

I. All equipment and installations shall meet or exceed minimum requirements of ADA, ANSI, ASTM, IEEE, NEC, NEMA, NFPA, OSHA, UL, and the State Fire Marshall.

J. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced, full-time Project Manager who is authorized to make decisions on behalf of the Contractor.

K. Warranty Requirements

1. Refer to Division 1 and General Conditions for Warranties.

2. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are required to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 1.

3. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

4. Perform the remedial work promptly, upon written notice from the Architect or Owner.

5. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year
period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.5 CODES, REFERENCES, AND STANDARDS

A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Architect's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Architect and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

E. The references to the following codes, references and standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON):

1. ANSI/TIA/EIA-569-C – “Commercial Building Standard for Telecommunications Pathways and Spaces”
2. NFPA 70 – National Electrical Code (NEC)
3. IEEE National Electrical Safety Code (NESC)
4. Americans with Disabilities Act (ADA) of 1990, as amended

1.6 DEFINITIONS:

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
2. As Directed - means as directed by the Architect, or his representative.

3. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring, as well as those for audio video systems and potentially other low-voltage systems such as security and fire alarm (electronic safety and security). This room is recognized in ANSI/TIA/EIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities.

4. Concealed - means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.

5. Conditionally Approved – the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.

6. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Design Professional, in addition to involvement by, and obligations to, the "Architect".

7. Furnish - “To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations.”

8. Furnished by Owner (or Owner-Furnished) or Furnished by Others: “An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.

9. Install - “To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use.”

10. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL’s that are acceptable to the AHJ, and standards that meet the specified criteria.

11. Provide - “To furnish and install complete, and ready for the intended use.”


13. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

14. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

15. Wet Location - means a pathway that does not protect cables from moisture levels that are beyond the intended operating range of “inside” premises cable.

a. For example: Slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand and gravel) is considered a “wet location.”

b. Also refer to the:

1) Telecommunications Distribution Methods Manual (TDMM) for definitions of Wet locations

2) In regards to work in this Division, Damp Locations (as defined by the NEC) are to be considered Wet Locations, and appropriately-rated cables are required for those areas/pathways.

16. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.

B. The terms "approved equal", “equivalent”, or “equal” are used synonymously and shall mean “accepted by or acceptable to the Design Consultant as equivalent to the item or manufacturer specified”.

C. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

D. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.

3. Sub-grade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Architect.

1.7 COORDINATION

A. Coordinate with other Divisions for Communications work to be included but not listed in Division 27 or indicated on Communications Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.

C. Refer to Communications Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.

D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Communications systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.

F. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

G. Work of this Division shall progress according to the "Construction Schedule" as described in Division 1 and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

H. Carefully check space requirements with other trades to insure that equipment can be installed in the spaces allotted.

I. Refer to Coordination requirements in specific sections for additional information.

J. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Architect and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.

K. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of Record Drawings.
L. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.

M. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.

2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

N. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Architect.

1.8 MEASUREMENTS AND LAYOUTS

A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.9 SUBMITTALS

A. Refer to Division 1 and General Conditions for general submittal requirements in addition to requirements specified herein. Refer to individual Division 27 Sections for additional submittal requirements. Unless otherwise noted, it is acceptable to submit electronic, PDF files.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be photocopies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

D. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct phases.

1. Pre-bid

   a. UON, submittals required prior to the due date for the submission of bids include:

      1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid) and as described within Substitutions paragraph of this section
b. Alternate personnel credentials to be reviewed for approval
   1) As required by individual sections in this Division

2. Bid
   a. UON, submittals required at the time of the submission of bids include:
      1) Bid Response Forms
      2) Unit Pricing (if required by sections in this Division)
      3) Contractor Qualifications (Previous project references)
         a) Provide a list of projects (no less than 2) of similar size, scope and type
            in which the Bidder has performed in a capacity comparable to the size,
            scope and type outlined in the Construction Documents. Provide the
            project name, relevant project information for comparison evaluation,
            and contact names with telephone numbers of each such project.
      2) Copies of certificates indicating current compliance with requirements of the
         Quality Assurance paragraphs of each section.
         a) Certificates or letters indicating factory-authorized dealer status for all
            major components specified.
      3) Personnel Qualifications
         a) Copies of certificates indicating current compliance with requirements
            of the Quality Assurance paragraphs of each section.
      4) On-site system project manager
         a) Identify by name and include contact information (e-mail, cell phone
            number, and mailing address).
         b) Include list of 2 recent projects under his/her charge, including Project
            Name, building owner (company or entity), completion date, and a
            reference contact including name, title, and phone number.
            Example: Gymnasium Expansion
                     Shelbyville School District
                     Completed: May 2013
                     Michael Smith, IT Director
                     913-742-5000
                     mrclient@owner.com
      5) Voluntary Bid Alternates
         a) As required by individual sections in this Division

2. Pre-construction
a. UON, submittals required after the award of the project to the winning bidder and prior to starting construction.

b. Submit the following items after the notice to proceed:

1) Division of Labor amongst sub-contractors. Including:
   a) Company Name
   b) Address
   c) Name of project manager for this project, including:
      i) E-mail
      ii) Telephone number

2) Schedule - A progress schedule, based on project final completion date and working backwards. Schedule shall include specific dates based on current completion date and shall include duration and milestones for at least the following:
   a) Off-site items under the scope of this work including: Shop drawings.
   b) On-site items under the scope of this work including: completion of equipment buy-out, completion of shop fabrication, rack installation, preliminary field testing of system, system programming, system commissioning, and system first use.
   c) On-site items under the scope of other work affecting this system including: completion of primary low voltage conduit, completion of secondary low voltage conduit, completion of AC power, completion and securable rack room, completion of ceiling (enough to install components).
   d) System commissioning (as applicable), including quiet time on site.

3) Personnel and Contractor Qualifications for work pertaining to the following specification section:
   a) Division 27 Section “Audio Video Systems”

4) Equipment List - A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products shall be listed in the same order as in the specification. List shall include length of manufacturer warranty if beyond one year.

5) Manufacturers’ Cut-sheets:
   a) At a minimum all cut-sheets shall contain the following:
i) The manufacturers’ name and logo somewhere on the page.

ii) Identification of all parts, pieces, and equipment. Items shall be specific or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the cut-sheet.

iii) Clear identification of all accessories, additional parts, or derivations of the product being submitted.

iv) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.

b) Cut-sheets are to be in the same order as in the specification.

c) “Cut-sheet” as used herein, indicates a concise engineering data sheet. Manufacturer’s operating guide (owner’s manual), quick start guide, or similar are not acceptable.

d) Equipment list and Manufacturers’ Cut-sheets shall be submitted and reviewed before any equipment and material is purchased.

6) Samples – refer to individual sections for exact sample requirements.

a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer shall cover return shipping if sample is to be returned.

c. Submit the following items sufficiently prior to installation of each respective portion of work:

1) Shop Drawings

a) For Common Work such as pathways, boxes, and firestopping.

i) Refer to Division 27 Sections “Common Work Results for Communications” and” for exact shop drawing requirements.

b) For the Audio Video Systems and associated Common Work such as pathways, boxes, and firestopping.

i) Reviewed and stamped by the Contractor’s CTS-I, as defined in Division 27 Section “Audio Video Systems”.

ii) Refer to Division 27 Sections “Common Work Results for Communications” and “Audio Video Systems” for exact shop drawing requirements.

d. As required by individual sections in this Division
3. Project Completion
   a. UON, submittals that are required after the substantial completion but prior to project closeout include:
      1) Record Drawings
         b) As defined in Record Drawings paragraph within this section
      2) Operation and Maintenance Data
         a) As defined in Operation and Maintenance Data paragraph within this section
      3) Project Test Reports
         a) As defined within specific sections of this Division.
      4) Cable Databases (as applicable)
      5) Warranty Certificate(s)
         a) For products and systems with manufacturer warranties beyond 1 year.
      6) Lead Installer / Project manager letter with signature stating the project has been installed in accordance with referenced industry standards and contract documents.
      7) As required by individual sections in this Division

B. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Design Consultant that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Design Consultant’s designated representatives. Contractor shall allow the Design Consultant review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

C. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept.

D. Transmit submittals as early as required to support the project schedule. Allow for two weeks Design Consultant review time, plus to/from review and processing time via the Architect, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before construction starts.
E. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted.

F. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

G. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.

H. Submittals shall contain the following information. Submittals not so identified will be returned to the Contractor without action:

2. The project name

3. The applicable Specification Section and paragraph

4. The submittal date

5. The submitting (sub-)contractor’s company name and the project manager’s name and contact information.

I. Each submittal package shall be transmitted independently, each under its own transmittal, and clearly stating the contents of the submittal (i.e. “Equipment List”, “Manufacturers’ Cut-sheets”, etc.). Piecemeal submittals will not be reviewed.

J. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring and service connection data.

K. The Design Consultant’s checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Design Consultant’s and Architect’s attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.

L. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.

M. Maintain a complete set of reviewed and stamped shop drawings and product data on site. Track any changes to show on the Record Drawings and Operation and Maintenance Manuals.
E. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

1.10 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect’s written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect’s written authorization and Engineer’s release agreement form must be received before electronic drawing files will be sent.

1.11 SUBSTITUTIONS

A. Refer to Bid documents, General and Supplementary Conditions and Division 01 Specification Sections for limitations and restrictions on substitutions in addition to requirements specified herein.

B. For products, materials, equipment, or systems for which this Division specifically identifies, the Contractor shall use it as the basis for their bid. However, if the Contractor feels a substitute is appropriate for consideration they may submit, as required in these documents prior to bid, for approval by the Design Consultant.

C. Materials, products and equipment described in the Bidding Documents establish a standard of required function, performance, dimension, appearance and quality to be met by the proposed substitution.

D. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

E. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

   a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

   b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

   c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
d. Same warranty will be furnished for proposed substitution as for specified Work.

e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

F. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered with receipt of Bids, unless the Architect and Design Consultant have received from the Bidder a written request for approval to bid a substitution at least ten calendar days prior to the date for receipt of Bids, and have approved the substitution request.

3. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work of related trades are not permitted.

4. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner, including verbal. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials which meet the performance as stated or implied in the Contract Documents.

1.12 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 and General Conditions for Operation and Maintenance Data requirements in addition to requirements specified herein.

B. Prior to Substantial Completion of the project, furnish to the Architect, for Design Consultant’s review, and for the Owner’s use, the following Division 27 Items:

1. An electronic transmittal containing the following in PDF file format:

   a. Equipment List of all installed components
   
   b. Manufacturers’ Cut-sheets for all installed components
   
   c. Manufacturers’ installation, operation, service and maintenance data, including all literature supplied with each item of equipment
   
   d. Equipment Warranties, guarantees, serial numbers, etc.
   
   e. As applicable, all Network documentation, including a list of all active devices connected to the network along with their respective MAC and IP addresses, and passwords
   
   f. PDF versions of all system test results
g. Project specifications

h. Copy of Record Drawings, per Record Drawings paragraph requirements

i. Copies of all Shop Drawings not reflected in the above items, including any physical details or other “as installed” items

j. Local contacts complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications

2. An electronic transmittal containing the following in raw file format:

a. All system software code, as applicable

b. Raw file format system test results

3. As applicable under Division 1, physical printed copies for the Owner’s use shall conform to the following:

a. Provide electronic PDF file in a three-ring, loose-leaf, hard-back notebook form (binder), divided and tabbed. Utilize clear plastic overlays on the front and spine and create insert with all applicable project and binder information.

b. Subdivide major system categories into separate volumes.

c. Provide a Table of Contents for each volume.

d. Include all raw file format content on electronic media (USB stick or equivalent)

C. Instruct the Owner’s permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Refer to individual sections in this Division for additional requirements.

1.13 APPROVED EQUIVALENTS

A. For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant’s acceptance or rejection is final.

1.14 VOLUNTARY ALTERNATE BIDS

A. Voluntary alternate bids will be accepted provided they are included in conjunction with a valid base bid or bid approved as an acceptable substitution by the Design Consultant.

1.15 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division.
B. Obtain the Owner’s or Owner’s representative’s written acceptance when the specified spare parts for that section are delivered.

1.16 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. Maintain on a daily basis a set of jobsite work prints of the Issued for Construction Drawings, reflecting an accurate dimensional record of deviations between work shown on Drawings and that actually installed.

1. Record dimensions clearly and accurately to delineate the work as installed; suitably identify locations of all equipment by at least two dimensions to permanent structures.

2. Pay particular attention to those items that require locating for servicing. This includes, but is not limited to, above-ceiling items such as:
   a. Backbone cable and conduit routing
   b. Pullbox and junction box locations

3. Record all wire labeling information.

C. At the completion of the project, obtain reproducible electronic copies of the final Drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done electronically in AutoCAD and saved to PDF and AutoCAD 2007 dwg format. Mark each sheet “Record Drawing”, along with the date, and deliver these Record Drawings to the Architect.

1. Drawings shall utilize the Contractors title block and include specific information indicating the system design was by the Design Consultant.

1.17 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect and Design Consultant.
D. Be responsible for the safe storage of tools, material and equipment.

1.18 TEMPORARY FACILITIES

A. Refer to Division 1 and General Conditions for Temporary Facilities requirements.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies’ recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1.19 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:

1. The Drawings describe the general nature of remodeling to the existing building; however, visit the Site prior to submitting bid to determine the nature and extent of work involved.

2. Schedule Work in the existing building with the Owner.

3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves Communications systems, equipment, raceways, equipment supports or foundations and materials.

4. Remove articles that are not required for the new Work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.

5. Relocate and reconnect Communications facilities that shall be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where communications equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.

6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.

7. Protect adjacent materials indicated to remain. For Work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

8. Locate, identify, and protect Communications services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services shall be interrupted, provide temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services that transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

D. Use of explosives is not permitted.

E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Use only products listed for their intended use by a NRTL, except products for which no relevant standards exist.

B. Where products are required to be NRTL listed, classified, approved or otherwise each individual item shall bear the NRTL mark by permanent means.

C. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

D. Products and materials shall not contain asbestos, PCB, or any other material, which is considered hazardous by the Department of Environmental Protection or any other authority having jurisdiction.

E. As directed by the Architect, replace materials of less than specified quality and relocate work incorrectly installed.

F. Refer to individual sections for labeling requirements.

G. Install materials and equipment with qualified trade people.

H. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.

I. Follow manufacturer’s instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.

J. Where factory testing of equipment is required to ascertain performance and attendance by the Owner’s representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.

K. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be de-rated with the method of de-rating identified on the submittals.
L. Enclosures for Communications Infrastructure equipment installed in mechanical equipment rooms shall be NEMA type 1 gasketed. Enclosures for communications Infrastructure equipment installed outdoors shall be NEMA type 3R.

M. If products and materials are specified or indicated on the drawings for a specific item or system, use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of product data submittal.

N. Ship and store all products and materials in a manner that will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain a replacement. Repairs of damaged goods will only be permitted with prior written permission of the Owner/Design Consultant.

O. Part numbers and product codes in these specifications are correct as of the time of writing. Manufacturers may, however, change part numbers and product codes on short notice. In cases where part numbers or product codes differ from technical specifications for a particular product, provide products meeting the minimum technical specifications of the products in the specifications. Notify the Owner/Design Consultant of any product code and or part number changes on the material list submittal.

PART 3 - EXECUTION

3.1 FEES AND PERMITS

A. Secure and Pay all required fees and obtain all required permits related to the Communications Infrastructure installation.

B. Pay royalties or fees in connection with the use of patented devices and systems.

3.2 SELECTIVE DEMOLITION

A. Refer to Division 1, Division 2, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. Examine the site to observe existing conditions before submitting a bid.

C. General: Demolish, remove, demount, and disconnect abandoned communications materials and equipment indicated to be removed and not indicated to be salvaged or saved.

D. Schedule demolition in advance. Schedule work to avoid disruption of normal operations.

E. Materials and Equipment to Be Salvaged:

1. Communications Infrastructure equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and legally and properly disposed of.

2. Remove, demount, and disconnect existing communications materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
F. Reconnect circuits serving equipment required to remain in service to other cable termination fields, patch panels or splices as indicated on the Drawings or as appropriate. Provide additional cable and termination hardware where there is insufficient available capacity in remaining existing equipment for reconnection.

G. Remove existing conduit and wire back to the Communications Equipment room, unless a specific extent of removal is indicated on the Drawings.

H. Communications Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
   a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
   b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 27.

3.3 EXISTING CONDITIONS

A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.

B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.4 EXISTING SERVICES

A. Existing Communications Infrastructure services not specifically indicated to be removed or altered shall remain as they presently exist.

B. Where existing services interfere with new construction, alter or reroute such existing equipment to facilitate new construction after obtaining written permission from the Architect. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.

C. Schedule and coordinate with the Utility Company, Owner and with the Architect all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.

D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.
E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.

F. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Architect.

G. Make repairs and restoration of utilities before workmen leave the project at the end of the workday in which the interruption takes place.

H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.5 EXAMINATION OF SITE

A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical, electrical and Communications installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

3.6 WORK IN EXISTING FACILITIES

A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.

B. Schedule Work in the existing facility with the Owner.

C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves Communications systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.

D. Remove all of these articles that are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.

E. Channel walls and floors as required to produce the desired result; however, obtain permission from the Architect or Owner for all channeling not specifically noted on the Drawings.

3.7 CLEANING

A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.

B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.
C. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.

D. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.

E. Touch up and restore damaged finishes to their original condition.

F. All Communications Infrastructure equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation by the Architect as required.

3.8 DELIVERY, DRAYAGE AND HAULING

A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required, and provide proper storage and protection until the time it is required. Pay for all costs of demurrage or storage.

B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, then Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer’s supervision, shoring, general construction modification, delays, overtime costs, etc. at no additional cost to the Owner.

3.9 EQUIPMENT AND MATERIAL PROTECTION

A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.

B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.

C. Provide adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

3.10 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all Communications equipment furnished and/or installed under this Division.

B. Check and test protective devices for specified and required application, and adjust as required.

C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
D. Notify the Architect immediately of all operational failures caused by defective material, labor or both.

E. Refer to individual Sections for additional and specific requirements.

3.11 START-UP OF SYSTEMS

A. Prior to start-up of Communications systems, check all components and devices, to confirm compliance with manufacturers' recommended installation procedures.

B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

C. Refer to individual Sections for additional and specific requirements.

3.12 OPERATING INSTRUCTIONS

A. Instruct Owner’s operating personnel in proper starting sequences, operation, shutdown, general maintenance and preventative maintenance procedures, including normal and emergency procedures.

B. Refer to individual Sections for additional and specific requirements.

3.13 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit complete Operation and Maintenance Data.

2. Submit complete Record Drawings.

3. Perform all required training of Owner’s personnel.

4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.

5. Perform start-up tests of all systems.

6. Remove all temporary facilities from the site.

7. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.

B. Request in writing a review for Substantial Completion. Give the Architect at least seven (7) days notice prior to the review.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect and Design Consultant will prepare a “final list” of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.14 EARLY OCCUPANCY

A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.

1. Refer to individual sections for additional requirements.

B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION 270010
SUBSTITUTION REQUEST FORM
To Project Engineer: __________________________ Request # (GC Determined): ____________

Project Name: ____________________________________________________

Project No/Phase: ______________________________ Date: ________________

Specification Title: ____________________________________________

Section Number: _______________ Page: __________ Article/Paragraph: __________

Proposed Substitution: ____________________________________________

Manufacturer: __________________________ Model No.: __________________

Address: __________________________________ Phone: ________________

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

Differences between proposed substitution and specified Work: __________________________

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: __________

Reason for not providing specified item: ____________________________________________

Similar Installation:

Project: __________________________ Architect: __________________________

Address: __________________________ Owner: __________________________

_________________________ Date Installed: __________________________

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: __________________________

GENERAL COMMUNICATIONS REQUIREMENTS 270010-27
Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

C. Proposed substitution is consistent with the Contract Documents and will produce indicated results.

D. Proposed substitution does not affect dimensions and functional clearances.

E. Proposed substitution has received necessary approvals of authorities having jurisdiction.

F. Same warranty will be furnished for proposed substitution as for specified Work.

G. Same maintenance service and source of replacement parts, as applicable, is available.

H. Proposed substitution will not adversely affect other trades or delay construction schedule.

I. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.
Manufacturer’s Certification of Equal Quality:

I ____________________________ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

____________________________________  Date  ____________________________  Company

Manufacturer’s Representative

Engineer Review and Recommendation Section

Recommend Acceptance  □ Yes  □ No

Additional Comments:  □ Attached  □ None

Acceptance Section:

____________________________________  Date  ____________________________  Company

Contractor Acceptance Signature

____________________________________  Date  ____________________________  Company

Owner Acceptance Signature

____________________________________  Date  ____________________________  Company

Architect Acceptance Signature

____________________________________  Date  ____________________________  Company

Engineer Acceptance Signature
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SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements as follows:

1. Grounding and Bonding for Communications
2. Pathways for communications systems.
   a. Cable Hook Systems
   b. Conduit
   c. Surface Raceways
   d. Outlet Boxes
   e. Floor Boxes
   f. Pull Boxes
3. Firestopping Systems
4. Access Panels
5. Identification

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Division 27 Section “General Communications Requirements”

B. Division 07 Section “Penetration Firestopping” for fire stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.

C. Refer to Division 26 for materials and methods for additional requirements for the following:

1. Division 26 Section “Common Work Results for Electrical” for electrical systems coordination.
2. Division 26 Section “Equipment Wiring Systems” for electrical systems coordination.
3. Division 26 Section “Grounding and Bonding for electrical systems” for electrical systems coordination.
4. Division 26 Section “Hangers and Supports for Electrical Systems” for electrical systems coordination.

5. Division 26 Section “Raceways and Boxes for Electrical System” for electrical systems coordination.

1.3 CODES, REFERENCES, AND STANDARDS

A. Follow all applicable codes, references, and standards listed in Division 27 Section “General Communications Requirements”.

B. Follow all guidelines listed in Division 27 Section “General Communications Requirements”.

C. The Contractor is responsible for following the correct revision or printing (UON) of all applicable codes, references, standards, and guidelines.

D. Follow the additional codes, references, standards and guidelines:
   1. ASTM E 814 and ANSI/UL1479 –“Fire Tests Through Penetration Firestops”
   2. ASTM E 84 and ANSI/UL 723 “Surface Burning Characteristics of Building Materials”

1.4 DEFINITIONS

A. Cable Tray System – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.

B. Common Work – all Work specified in this section.

C. Conditionally Approved - the manufacturer has been found reputable by the Design Consultant, but the Design Consultant has not verified that the product offering by manufacturer meets to all specification and project requirements. Contractor shall adhere to submittal review process for final approval on products.

D. Conduit Body – A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.

E. Conveniently Accessible – Capable of being reached from the floor or via the use of an 8 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.

F. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.

G. Floor Box Assembly (Floor Box) – An on-grade solution or above grade (with a native fire classification or in combination with an approved Firestopping System) solution for in-floor
terminations. The Assembly consists of pour pan (as applicable), Firestopping System (as applicable), floor box (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates), and access door / cover / lid.

H. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

I. IMC – Intermediate Metal Conduit

J. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

K. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.

L. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn’t identified on the drawings, assume the Main Communications (MDF) also acts as the Point of Entrance.

M. Poke Through Assembly (Poke-Thru) – An above grade solution with a native fire classification for in-floor terminations. The Assembly consists of pre-pour sleeve (as applicable), Firestopping System, fire resistant conduit stub, poke thru (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates, as applicable), and access door / cover / lid.

N. Quality Control Specialist – as it pertains to Work within this section, Quality Control Specialist is the Project CTS-I, as defined in Division 27 Section “Audio Video Systems”, for Common Work for AV.

O. RMC – Rigid Metal Conduit

P. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

Q. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

R. UL – Underwriters Laboratory

1.5 QUALITY ASSURANCE

A. Submittals and Shop Drawings for all Common Work Results specified in this section shall, if not created by, be reviewed by the Quality Control Specialist.

1. The Quality Control Specialist shall stamp all relevant submittals for their associated Division 27 sections, which indicates that at a minimum the proposed work has been reviewed by them and found to be in compliance in regards to:
a. All applicable codes and industry standards and guidelines referenced in Division 27.

b. Being fully-coordinated with all other trades and to be installed per the Construction Documents.

c. And installed per manufacturer’s direction.

B. The Quality Control Specialist shall also make weekly inspections during construction to ensure all work installed per this section is correct.

1. Any deficiencies encountered prior to and during installation shall be corrected by the installing contractor under the direction of the Quality Control Specialist and/or the Design Consultant.

C. Firestopping Systems

1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.

2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:

   a. FM Research, approved in accordance with FM AS 4991.

   b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

1.6 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”.

B. Pre-bid

1. Product substitutions

C. Pre-construction

1. Contractor Qualifications for Firestopping Systems: Provide copies of training/certification as required in the Quality Assurance portion of this specification section.

2. Equipment List

3. Manufacturers’ cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:

   a. In addition to Division 27 Section “General Communications Requirements”, include the following:

      1) Size – including physical and loading dimensions
2) Maximum span length

3) Weight supported

4) Type

5) Fittings to be used

6) Method of attachment to structure

7) Firestop system assembly information for each system to be installed:
   a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
      i) Firestop manufacturer
      ii) UL system number
      iii) F, T, and L Ratings
      iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.

8) As well as any additional information required by individual sections of this Division

4. Shop Drawings
   a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.

1) Each pathway shall be identified by type and size on the drawings.
   a) Example #1: 4" EMT
   b) Example #2: 4" x 12" Cable Tray

2) Each grounding conductor shall be identified by size (and insulation):
   a) Example: #3/0 insulated ground

3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.
   a) Example #1 – Firestopping Sleeve:
      EZ-Path Series 22, UL System W-L-3255
b) Example #2 – Backbox in Fire-Rated Wall:
   Specseal Power Shield, UL System QCSN/CLIV.R14288

4) Each pullbox and access panel shall be identified by size and height above
   finished floor.
   a) Pullbox Example: Pullbox 8” x 24” x 40” approximately 12’ AFF.

b. Unless otherwise required by these specifications, it is permissible to show
   pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop
   drawing along with the cabling and system work to be installed through those
   pathways.

1) Division 271000 “Structured Cabling System” and Division 274100 “Audio
   Video Systems” and their individual pathways shall not be combined into a
   single shop drawing; shared pathways such as cable tray shall be shown on
   both shop drawings.

D. Project Completion

1. Record Drawings:
   a. Based on the work prints kept on the jobsite and official changes to the Contract
      Documents (such as Change Orders, Architect’s Supplemental Instructions, and
      Design Change Directives), create final drawings incorporating any minor and
      approved changes to the submitted Shop Drawings. Submit this set in accordance
      with the Record Drawings requirements of Division 27 Section “General
      Communications Requirements”.

   b. The Quality Control Specialist is to review the installation and Record Drawings
      for the Common Work Results required for their scope of work and to stamp the final
      Record Drawings with their RCDD or CTS-I stamp before submission. By stamping
      the Record Drawings, the Quality Control Specialist indicates that the Common
      Work Results have been installed per the Contract Documents and all associated
      codes, standards, and guidelines, and any minor changes or official changes to the
      drawings have been incorporated into the Record Drawings.

2. Pictures of each Firestopping System (with visible label).

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce
   headroom are indicated.

2. To allow right of way for piping, ducts, and other systems installed at required slopes and/or
   elevations.

3. So connecting raceways, cables, and wireways will be clear of obstructions and of the
   working and access space of other equipment.
**Project Manual For:**
**Mizzou Sports Arena - Renovate Basketball Spaces**
**Project Number: CP200131**
**March 3, 2020**

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

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

D. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.8 **NOISE CRITICAL SPACES**

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The list below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants or sleeves.

1. Meeting room demising walls
2. Studio area

**PART 2 - PARTS AND MATERIALS**

2.1 **GROUNDING AND BONDING FOR COMMUNICATIONS**

A. Refer to drawings and Division 27 Sections “Telecommunications Equipment Room Fittings” and “Audio Video Systems” for exact grounding and bonding requirements.

2.2 **PATHWAYS FOR COMMUNICATIONS SYSTEMS**

A. General

1. All non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable
2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables

B. Cable Hook Systems ("J-hooks")

1. The following manufacturers are Conditionally Approved.
   a. Cooper/B-Line
   b. Erico/Caddy
   c. Monosystems
   d. Panduit
   e. Snake Tray
   f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications
   
a. Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations
b. Be open for easy lay-in and removal of cabling
c. Be designed so the mounting hardware is recessed to prevent cable damage
d. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3
e. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304
f. Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions
g. Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed

3. Cable hooks for installation above ceilings shall be
   
a. B-Line series BCH21, BCH32, BCH64
b. Caddy CABLE-CAT 21 or 32 series hangers
c. Or equivalent from Conditionally Approved manufacturer

C. Conduit
   
1. Specifications
   
a. Refer to Electrical Division 26 for specific product and material information.
   "1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.

b. Conduits provided as connection to incoming services, utilities, including private services to other buildings or outside connection points shall be rigid metal or intermediate metal conduit at the point it enters the building, emerges from an exterior wall or ground floor slab to the final termination/transition point.

c. If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet (15.3 m) for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated. Generally this connection point will be a designated
Entrance Room for Communications or the Main Telecommunication space. If space has not been identified the contractor shall request information prior to bid.

d. Follow Electrical Division 26 for conduits underground, in slab or anywhere not within the building.

e. Provide conduit as indicated on the Drawings or required by this Specification. Minimum conduit size shall be 1 inch (25.4 mm). Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as communications(Telecom or AV), at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.

f. Route an empty conduit from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, route conduits to the nearest accessible corridor ceiling or communications space.

<table>
<thead>
<tr>
<th>Number of Telecommunications Outlets/Connectors</th>
<th>Conduit Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 4</td>
<td>1 inch (25.4 mm)</td>
</tr>
<tr>
<td>Up to 9</td>
<td>1-1/4 inch (31.8 mm)</td>
</tr>
</tbody>
</table>

D. Acoustical Pathway

1. Specifications
   a. For use in non-rated walls only.
   b. For use in place of conduit sleeves through walls of noise critical spaces.
   c. Plenum Rated (to UL2043)
   d. Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.

2. Manufacturer shall be:
   a. Hilti CS-SL SA
   b. Specified Technologies, Inc. - NEZ33

E. Surface Raceways

1. The following manufacturers are Conditionally Approved.
   a. Surface Metal Raceways
      1) Hubbell
2) Legrand/Wiremold
3) Mono-Systems Inc.
4) Panduit
5) Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

b. Surface Nonmetallic Raceways
   1) Hubbell
   2) Legrand/Wiremold
   3) Mono-Systems Inc.
   4) Panduit
   5) Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

2. Specifications
   a. Raceways shall be sized per the quantity and size of the installed cables, plus 50% spare capacity. Minimum cross-sectional area shall be 1 inch.
   b. Single gang and double gang surface boxes shall be a minimum of 2-1/2 inches deep.
   c. Color shall be painted to match existing wall.

3. Manufacturer shall be:
   a. Submit product cutsheet(s) from Conditionally Approved manufacturer listed above.

F. Outlet Boxes
   1. Specifications
      a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
      b. Telecommunications – for outlets shown on T drawings:
         1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8” deep. Depth shall match that of wall gypsum board(s).
            a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings); or
b) RANDL T-55017; or

c) Or equivalent from
   i) Emerson/Appleton
   ii) Thomas & Betts/Steel City
   iii) Approved Substitution

2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches (101.6 mm) width by 4 inches (101.6 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).

   a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.

   b) Or equivalent from
      i) Emerson/Appleton
      ii) Thomas & Betts/Steel City
      iii) Approved Substitution

3) For 6" or 8" deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inches deep.

   a) Single gang – RACO 695R, no substitutes

   b) Double gang – RACO 696R, no substitutes

4) Weatherproof: Aluminum die cast, weatherproof box with 1” conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inches deep.

   a) Single gang – Thomas and Betts – IHD3-3 or equivalent

      i) Or equivalent from

         (1) Emerson/Appleton
         (2) Hubbell/RACO
         (3) Approved Substitution
b) Double gang – Thomas and Betts – 21HD5-3 or equivalent
   i) Or equivalent from
      (1) Emerson/Appleton
      (2) Hubbell/RACO
      (3) Approved Substitution

c. Audio Video – for outlets and boxes shown on T drawings:
   1) Refer to box schedule on T drawings for size requirements.
   2) Boxes specifically identified on drawings by manufacturer and model number form the basis of design. Other equivalent manufacturers will be considered, but fully-coordinate proposed alternative with Division 274100 contractor and submit substitution request.

G. Floor Boxes

1. General
   a. Provide a complete Floor Box Assembly.
   b. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.
   c. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.
   d. The following items are not provided per this specification section:
      1) Electrical receptacle(s) shall be provided per Division 26 Section “Wiring Devices” or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors.
      2) Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section “Communications Horizontal Cabling”. Coordinate all other Assembly components to ensure compatibility.
      3) Audio Visual custom termination plates and connectors shall be provided per Division 27 Section “Audio Video Systems”. Coordinate all other Assembly components to ensure compatibility.

2. Floor-mounted Telecommunications Outlet (Telephone and/or Data connections only, no Power): For slab on grade: watertight, Class 1, fully adjustable, cast iron box with removable partition. For slab above grade: concrete-tight, fully adjustable, stamped galvanized steel box. Brass cover plate and brass carpet ring. Provide aluminum cover plate and trim in lieu of brass when directed by Architect. Shallow slab-on-grade depths necessitate use of Box Type E. Shallow above-grade slabs necessitate use of Poke-
Through Outlet. Conduits shown on plans are minimum size; select appropriate floorbox based on slab type, thickness, and minimum conduit size.

<table>
<thead>
<tr>
<th>MFR</th>
<th>CAST IRON BOX</th>
<th>STAMPED STEEL BOX</th>
<th>COVER PLATE</th>
<th>CARPET TRIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel City</td>
<td>600 2SC (accepts up to (4) 2&quot; conduits)</td>
<td>68 D (accepts up to (4) 1&quot; conduits)</td>
<td>P60-DS or P60-1/2-2 for Furniture Feeds</td>
<td>P60-CP</td>
</tr>
<tr>
<td>Wiremold</td>
<td>889B (accepts up to (2) 1-1/4&quot; conduits)</td>
<td>886B (only accepts (1) 1&quot; conduit)</td>
<td>895GFI (Carpet) / 895TGF1 (Tile) or 896CK (Carpet) / 896TCK-1 (Tile) for Furniture Feed</td>
<td>n/a</td>
</tr>
<tr>
<td>Hubbell</td>
<td>For 4&quot; slabs – B253641 (accepts up to (4) 1&quot; conduits), For 4.75+&quot; slabs, B2506 (accepts up to (4) 1-1/4&quot; conduits)</td>
<td>For 4&quot; slabs only – B2527 (accepts up to (1) 1-1/4&quot; conduit and (1) 1&quot; conduit)</td>
<td>S3925 or S2725 for Furniture Feed</td>
<td>S3182</td>
</tr>
</tbody>
</table>

3. **Box Type E - Multi-Service (2 compartment):** For slab on grade: watertight, Class 1, fully adjustable, cast iron. For slab above grade: concrete-tight, Class 2, fully adjustable, stamped galvanized steel. Two compartments - one side plate with knockouts for communications faceplate and connectors; one side plate with provisions for one duplex receptacle. Furnish polycarbonate or nylon cover and flange piece with standard color as directed by Architect. Conduits shown on plans are minimum size; select appropriate floorbox based on slab type, thickness, and minimum conduit size. Shallow above-grade slabs necessitate use of Poke-Through Outlet.

<table>
<thead>
<tr>
<th>MFR</th>
<th>CAST IRON BOX</th>
<th>STAMPED STEEL BOX</th>
<th>RECEPTACLE PLATE</th>
<th>BLANK PLATE</th>
<th>COVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel City</td>
<td>664-CI (accepts (3) 1&quot; conduits in Communications compartment)</td>
<td>664</td>
<td>664-RP, 664-GP (Decor or Style)</td>
<td>664-BP</td>
<td>664-CST Series</td>
</tr>
<tr>
<td>Wiremold</td>
<td>RFB2-OG</td>
<td>RFB2-SS</td>
<td>RFB2DP, RFB2B (Decor or Style)</td>
<td>RFB2B</td>
<td>FP Series</td>
</tr>
<tr>
<td>Hubbell</td>
<td>3SFBC (accepts (1) 1-1/4&quot; conduit in Communications compartment)</td>
<td>3SFBS (accepts (1) 1&quot; conduit in Communications)</td>
<td>3SFBRP, 3SFBS (Decor or Style)</td>
<td>3SFBB</td>
<td>3SFBCxxA Series</td>
</tr>
</tbody>
</table>
4. **Box Type F / AV - Multi-Service (3 or 4 compartment):**
   a. Refer to Audio/Video drawings and specifications for exact floorbox requirements. If there are no AV drawings and specifications, then the following requirements apply:
      1) For slab on grade: watertight, Class 1, fully adjustable, cast iron, unless otherwise noted. For slab above grade: concrete-tight, Class 2, fully adjustable, stamped galvanized steel.
      2) Three to four compartments, 3-1/2-inch maximum overall depth, and provisions for power receptacles and communications faceplate and connectors. Furnish hinged cover and nylon or polycarbonate flanged trim with standard color as directed by Architect.
      3) Conduits shown on plans are minimum size; select appropriate floorbox based on slab type, thickness, and minimum conduit size.

H. **Pull Boxes – for interior use only**
   1. Specifications
      a. NEMA 1
      b. Refer to Execution section for sizing requirements.
   2. The following manufacturers are Conditionally Approved.
      a. Hoffman
      b. NEMA Enclosures
      c. Wiegmann
      d. Or Equivalent

2.3 **FIRESTOPPING SYSTEMS**

A. **General**
   1. All firestopping systems for Division 27 conduit, sleeves, cabling, boxes, etc. shall be from a single manufacturer, unless otherwise noted.
   2. The following manufacturers are Conditionally Approved.
      a. Hilti www.hilti.com
3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.

B. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)

1. Specifications
   a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer’s instructions.
   
   b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
   
   c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
   
   d. Allows the installation and removal of cables without the need to remove or add any materials.
   
   e. Used to seal penetrations of cables through fire rated partitions
   
   f. Not subject to the single manufacturer requirement

2. Manufacturer shall be:
   a. EZ-Path family of products by Specified Technologies Inc.
   
   b. Hilti Firestop Speed Sleeve CP 653 Series

C. Firestopping for Backboxes in Fire-Rated Walls

1. Specifications
   a. Used to seal backboxes in fire rated partitions.
   
   b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
   
   c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer’s instructions.

2. Manufacturer shall be:
   a. Hilti CP 617 or CFS-P PA
   
   b. Specified Technologies Inc., SpecSeal Power Shield
   
   c. Or equivalent from Conditionally Approved manufacturer.
D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications

1. For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.

2. Specifications:

   a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.

3. Manufacturer shall be:

   a. Hilti – submit UL System documentation for each floor/wall type and product cutsheets for all Hilti materials to be utilized

   b. Specified Technologies Inc. – submit UL System documentation for each floor/wall type and product cutsheets for all STI materials to be utilized

   c. Or equivalent from Conditionally Approved manufacturer.

2.4 ACCESS PANELS

A. Access Panels

1. Where pullboxes are required above inaccessible ceiling spaces, or for other required conditions, provide an appropriately-sized access panel. The following manufacturers are Conditionally Approved.

   a. Activar/J.L Industries www.activarcpg.com

   b. Acudor Products www.acudor.com

   c. Alfab/Barco www.alfabinc.com

   d. Elmdor Products www.elmdorproducts.com


   f. Milcor www.commercialproductsgroup.com

   g. Nystrom Building Products www.nystrom.com

   h. Williams Brothers www.wbdoors.com

   i. Wind-lock www.wind-lock.com

   j. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

2. Specifications:
a. **Steel Access Doors and Frames:** Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.

b. **Joints and seams:** Continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

c. **Frames:** 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:

   1) For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.

   2) For gypsum wallboard or plaster: perforated flanges with wallboard bead.

   3) For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

d. **Flush Panel Doors:** 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

e. **Fire-Rated Units:** Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

3. **Locking Devices:** Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

4. **Indicate proposed size and locations on pre-construction shop drawings.** No access panels shall be installed without Architect and Design Consultant approval.

### 2.5 IDENTIFICATION FOR COMMON WORK FOR COMMUNICATIONS SYSTEMS

**A. Labels**

1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.

   a. **Brady**
      
      www.bradycorp.com

   b. **Brother**
      
      www.brother-usa.com

   c. **Dymo**
      
      www.dymo.com

   d. **HellermannTyton**
      
      www.hellermanntyton.com

   e. **Panduit**
      
      www.panduit.com

   f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

2. **Specifications:**
a. Refer to additional requirements in Part 3 – Execution.
b. Refer to individual sections for additional identification requirements for specific work.

2.6 KEYS
A. Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

PART 3 - EXECUTION

3.1 PATHWAYS FOR COMMUNICATIONS
A. General

1. Refer to Electrical Division 26 for additional installation requirements.
   a. Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.

2. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.

3. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.

4. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.

5. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.

6. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).

7. Store and keep dry all products in original container in a climate controlled environment until installation is to occur.

8. Install all communications pathways:
   a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
   b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
   c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
d. So that the maximum allowable pulling tension is not exceeded.

e. To meet the requirements of the structure and the requirements of all other Work on the Project.

f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.

g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.

h. Parallel or perpendicular to building lines or column lines.

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

9. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall not be used to attach cables to cable supports; UON.

a. Except when supported by ladder racking within each Telecommunications room, UON.

10. Provide adequate communications pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for communications cabling purposes. Any deviation from this will not be accepted.

a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports. UON

b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports; UON

11. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).

12. Suspended cables shall be installed with at least 3 inches (76.2 mm) of clear vertical space above the ceiling tiles and support channels (T-bars).

13. Waterproofing

a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets.
required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.

b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

14. Cutting and Patching

a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.

b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.

c. Patch around all openings to match adjacent construction.

d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.

e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.

f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

15. Mounting Heights

a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.

1) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.

b. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.

c. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

16. Painting

a. Refer to Division 9 Section “Painting” for painting requirements.
b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual Sections and Division 9 of the Specifications; colors shall be as selected by the Architect.

c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.

d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

e. Where factory finishes are provided and no additional field painting is specified, touch-up or re-finish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

f. Provide touch-up paint as required by Specification Sections in this Division.

17. Fastenings

a. Fasten equipment to building structure in accordance with the best industry practice.

b. Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:

1) Wood: Wood screws.

2) Concrete and solid masonry: Bolts and expansion shields.

3) Hollow construction: Toggle bolts.

4) Solid metal: Machine screws in tapped holes or with welded studs.

5) Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.

c. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:

1) At concrete slabs provide 24 inch x 24 inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.

2) At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer
produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:

1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

f. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.

18. For large quantities of cables (greater than 50) that converge upon a common run such as at the TR, in corridors, and other areas, provide cable trays or other special supports that are specifically designed to support the required cable weight and volume.

19. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces. Install Acoustical Pathway(s) through walls of noise critical spaces

B. Access to pathways and associated equipment

1. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.

2. Provide an Access Panel where equipment or devices are located above inaccessible ceilings. Where access doors are necessary but not shown on the plans, coordination type and location with Architect and Design Consultant through an RFI.

a. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.

b. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.

3. Maintain all code required clearances and clearances required by manufacturers.

C. Cable distribution
1. Provide pathways for Telecommunications (Structured Cabling System) to allow cabling to be installed in the following manner:
   
   a. For typical new walls:
      
      1) Conduit from outlet location to accessible ceiling then j-hooks to main run of cable tray.
   
   b. For existing walls:
      
      1) For stud walls - “Ring and String”: Mud ring for faceplate, cabling run in hollow cavity of the wall and then j-hooks are utilized back to the nearest cable tray or serving Telecommunications Room/Space
      
      2) For masonry or inaccessible walls – Surface-mounted raceway to accessible ceiling space.
   
   c. For phone and data lines to all Elevator Equipment Rooms and Fire Alarm panels:
      
      1) Homerun method: Conduit from outlet location all the way back to the Telecommunications Room/Space.
   
   d. See drawings for clarification

2. Provide pathways for Audio Video Systems to allow cabling to be installed in the following manner:
   
   a. For typical new walls:
      
      1) Homerun method: Conduit from outlet/box location all the way back to the AV Rack identified on the drawings.
   
   b. For existing walls:
      
      1) For stud walls - “Ring and String”: Mud ring for faceplate, cabling run in hollow cavity of the wall and then j-hooks are utilized back to the nearest cable tray or serving Telecommunications Room/Space
      
      2) For masonry or inaccessible walls – Surface-mounted raceway.
   
   c. See drawings for clarification.

D. Conduits
   
   1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
   
   2. Adequate access shall be available where cables enter conduits
   
   3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and with TIA-607B – “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
4. Install conduits in the most direct route possible, running parallel to building lines.

5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.

6. Conduits which enter Telecommunications rooms shall extend 3 inches (76.2 mm) AFF or through the wall.

7. Conduits which enter Entrance Facilities shall extend 4 inches (101.6 mm) AFF or below the finished ceiling (if exists).

8. Flexible conduits may only be used where specifically allowed by these contract documents.
   a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length.

9. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.

10. No more than (2) 90° bends, or equivalent will be allowed between pullboxes.
    a. Each and any offset shall be considered a 90° bend.
    b. A pullbox is required wherever a reverse bend is installed.

11. The minimum bend radius for conduits is
    a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
    b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).

12. Any single conduit run may not serve more than (1) outlet location unless expressly indicated on the drawings.

13. Where building entrance conduits (for service provider and owner's WAN cabling) do not enter the building directly into the Communications Entrance Room/Facility, extend those entrance conduits via RMC or IMC into the Communications Entrance Room/Facility.

14. Conduits shall contain no electrical condulets (also known as LBs).
    a. Exception: Pre-approved (by the Design Consultant) condulets specifically manufactured for communications cabling and will maintain minimum bend radius for cabling to be installed. These locations are to be called out on the shop drawings.

15. Underground Conduit Requirements
    a. For Structured Cabling System horizontal cabling and pathways within the footprint of the building and serving voice and data outlets exterior to the building, such as emergency phones/towers, security cameras and wireless access points attached to exterior light poles, etc.
    b. For Audio Video System cabling serving pole-mounted loudspeakers, broadcast boxes, etc.
c. Requirements

1) Refer to applicable details on drawings for illustrative requirements.

2) Wherever practical, slab-on-grade floorboxes shall have conduit extended underground or in-slab from box to serving communications room or equipment cabinet.
   a) Only one horizontal bend is allowed, 90 degrees or less.
   b) Indicate proposed routing and stub-up locations on shop drawings.

3) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.
   a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are not to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.

4) Approved conduit types:
   a) When routed in slab-on-grade:
      i) Horizontal conduit shall be RMC or Schedule 40 PVC, including horizontal bends. If PVC is installed, also install tracer wire.
      ii) Vertical bends shall be RMC.
   b) When routed below slab-on-grade or outside the footprint of the building:
      i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
      ii) All vertical and horizontal bends shall be RMC.

E. Outlet boxes

1. No outlet boxes shall be located back-to-back in a wall cavity.
   a. Where possible offset to next stud cavity, with a minimum of 6 inch (152.4 mm) separation.

2. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.

3. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
4. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. PullBoxes

1. Pullboxes shall be placed in Conveniently Accessible locations.

2. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.

3. Pullboxes above an accessible ceiling shall:
   a. Be aligned directly over the ceiling grid to allow access
   b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles

4. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.

5. Size pullboxes according to the following chart (all sizes are minimums):

<table>
<thead>
<tr>
<th>Conduit Trade Size</th>
<th>Width</th>
<th>Length</th>
<th>Depth</th>
<th>Width Increase for Additional Conduit (of same size)</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾” or smaller</td>
<td>4”</td>
<td>4”</td>
<td>2-1/8”</td>
<td>Not applicable</td>
</tr>
<tr>
<td>1”</td>
<td>4”</td>
<td>16”</td>
<td>3”</td>
<td>2”</td>
</tr>
<tr>
<td>1-1/4”</td>
<td>6”</td>
<td>20”</td>
<td>3”</td>
<td>3”</td>
</tr>
<tr>
<td>1-1/2”</td>
<td>8”</td>
<td>28”</td>
<td>4”</td>
<td>4”</td>
</tr>
<tr>
<td>2”</td>
<td>8”</td>
<td>36”</td>
<td>4”</td>
<td>5”</td>
</tr>
<tr>
<td>2-1/2”</td>
<td>10”</td>
<td>42”</td>
<td>5”</td>
<td>6”</td>
</tr>
<tr>
<td>3”</td>
<td>12”</td>
<td>48”</td>
<td>5”</td>
<td>6”</td>
</tr>
<tr>
<td>4”</td>
<td>16”</td>
<td>60”</td>
<td>8”</td>
<td>6”</td>
</tr>
</tbody>
</table>

3.2 LABELING

A. Labeling Installation

1. Labels that are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on:
   a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section. Take picture of each firestopping system (with label visible) to include with Project Completion submittal.
   b. All pathways (e.g., conduit, innerduct, etc.) installed under this work.
1) Label all conduit and innerduct with “TELECOM” or “AV” according to the intended system/use of the installed (or future) cabling. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.

   a) For wall stub-up locations, label overhead only.

   b) For conduits greater than 10’, label both ends of conduit with far end location and Room/Number.

      i) Example – “AV to AV Rack R01”.

   c) For conduits that stub directly up or into a Communications Room, label both ends of conduit.

      i) Example: underslab conduit from Telecom Room 1A to the Floor Box in Conference Room 101A shall be labeled as follows:

         (1) Conduit stub-up location in Telecom Room 1A – “Telecom to Conf. Rm 101A Floorbox”

         (2) Bottom of floorbox, immediately adjacent to serving Telecom conduit – “Telecom to Telecom Room 1A”

2) All pullboxes and junction boxes for Communications shall be labeled “TELECOM PULLBOX” or “AV JUNCTION BOX” on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.

   a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie “To AV Box A:####:## in Control Rm 212”.

3) In addition to the above labeling requirements, for pathways above accessible ceiling, paint the cover of all pullboxes/junction boxes <insert color> and stripe all conduits every 5’ with that color.

4) Wherever raceways for future use are terminated outside of the building, stake the location with a 2-foot long, 1 inch x 1-inch clear heart redwood stake.

   c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.

   d. Refer to individual Division 27 Communications sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

   1. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall
be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.

2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.
   
a. Assume all floors are fire-rated, unless otherwise noted.

b. Also install fire stops at any other locations indicated in the Specifications or Drawings.

3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
   
a. Fire stop Manufacturer

b. Installer and company

c. Date installed

d. UL system number with all relevant ratings indicated

4. Include labels in each telecom room in which one or more fire rated walls is installed. Provide a 2” block letter stencil label on the inside of the telecom room to indicate rating for each barrier.

5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

B. Penetration Sealant – Conduits

1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.

C. Penetration Sealant – Voids, Cavities, and Openings

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.

2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.

3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.

D. Fire-Rated Pathway Device
1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.

2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.

3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer’s recommendations.

4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.

5. Secure wall plates (where required) to devices per the equipment manufacturer’s recommendations.

END OF SECTION
SECTION 271100 - TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fittings that are within the physical walls of the communications equipment rooms to support the Telecommunications System. Fittings include but are not limited to:

1. Grounding & Bonding

B. Section does not specify fittings such as cables, cable terminations, termination blocks, and patch panels for structured cable system (SCS). These components are furnished by the Owner.

C. Section does not specify fittings for audio video system(s). These components are specified in the Division 27 Section “Audio Video Systems”.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

A. Follow all applicable codes, references, and standards listed in Division 27 Sections “General Communications Requirements”.

B. Division 26 Section “Grounding and Bonding for Electrical Systems”.

1.3 DEFINITIONS

A. Communications Equipment Room – This CSI MasterFormat™ term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass TIA/EIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).

B. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article 770 “Optical Fiber Cables and Raceways” and Article 800 “Communications Circuits” of NFPA 70 “National Electrical Code”.

C. Communications Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19” or 23” inches.

D. Communications Rack – A floor or wall mount unit without side panels. Racks can be 2-post or 4-post. Communications equipment is supported by mounting rails separated at 19” or 23” inches.

E. Communications Frame - A floor or wall mount unit without side panels. Communications termination blocks are the only communications devices mounted to the unit.
F. Communications Enclosure – A floor or wall mount unit enclosed with side panels. Communications equipment is not supported by mounting rails separated by 19” or 23” inches. This definition shall encompass BICSI Telecommunications Distribution Methods Manual term for Telecommunications Enclosure (TE).

G. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

H. Grounding Equilizer (GE) – The conductor that interconnects elements of the telecommunications grounding infrastructure.

I. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar.

J. Telecommunications Main Grounding Busbar (TMGB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

1.4 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Sections “General Communications Requirements”.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.

B. Communications equipment room fittings shall be listed by a NRTL.

PART 2 - PARTS AND MATERIALS

2.1 TDMM-COMPLIANT TELECOMMUNICATIONS GROUNDING AND BONDING SYSTEM

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the most recent edition of BICSI’s Telecommunications Distribution Methods Manual. Major components include:

   a. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the TDMM.

2. Available Component Manufacturer[s]:

   a. Chatsworth
b. Cooper B-Line

c. Erico

d. Harger

e. Hoffman

f. Panduit

2. Conductor Manufacturers

a. Shall be from the list of Component Manufacturers; or

b. Shall be from the list of Manufacturers in Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.

B. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)

1. Specifications

a. Shall be copper.

b. When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.

c. When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.

d. Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer’s name.

2) Copper Conductor Gauge.

3) UL listing.

e. Cable jacket shall be green with black lettering.

C. Connectors / Connections

1. Specifications

a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.

b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc

2. Compression Lugs
a. Specifications
   1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
   2) Shall include inspection port.
   3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)

b. Manufacturer shall be:
   1) Harger GECLB Series
   2) Or Approved Equivalent

3. Conductor to conductor connection
   a. Specifications
      1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.
   b. Manufacturer – Exothermic Weld
      1) Erico CADWELD
      2) Harger Ultraweld
      3) Or Approved Equivalent
   c. Manufacturer – Irreversible Compression connector
      1) Burndy HYGROUND
      2) Or Approved Equivalent

4. Connector for conduit to cable
   a. Specifications
      1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the TMGB/TGB.
   b. Manufacturer shall be:
      1) For 1" diameter and larger conduits – Harger series CPC electro tin-plated pipe lamp
2) For less than 1” diameter conduits – Harger TBGC4SCS electro tin-plated conduit bonding clamps

3) Or Approved Equivalent

5. Connector for conductor to cable tray
   a. Specifications
      1) For metallic cable trays that extend to the Telecommunications Room.
   b. Manufacturer shall be:
      1) Harger electro tin-plated cable tray bonding clamps – TBCTC
      2) Or Approved Equivalent

D. Insulated Grounding Bushings
   1. Specifications
      a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
      b. Shall be UL Listed for copper conductors.
      c. Shall include lug for easy connection of conductor to TMGB/TGB.
   2. Manufacturer shall be:
      a. O-Z/Gedney IBC-L
      b. Or Approved Equivalent

PART 3 - EXECUTION

3.1 GROUNDING AND BONDING INSTALLATION

A. General:
   1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. “Daisy chaining” of Telecommunications ground bus bars back to the TMGB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein.
2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications
cable management pathways so as to achieve a “coupled bonding conductor” effect.

3. Where insulated conductors are necessary provide adequately rated insulation jackets or
pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run
entirely in conduit, etc.)

4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it
is necessary to place grounding and bonding conductors in ferrous metallic conduit that
exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the
conduit using a grounding bushing or a No. 6 AWG conductor, minimum.

5. The Bonding Conductor for Telecommunications (BCT), each Telecommunications
bonding backbone (TBB) conductor, and each grounding equalizer (GE), shall be green
or marked with a distinctive green color

   a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot
      (0.3 meter) by appropriate methods

   b. Indicate proposed and actual routing of these conductors on overall floor plans in
      both the pre-construction Shop Drawings and Record Drawings, respectively.

6. Follow additional installation requirements from NECA/BICSI 607-2011 “Standard for
Telecommunications Bonding and Grounding Planning and Installation Methods for
Commercial Buildings”.

B. Required Grounding Connections:

1. Provide and install one individual ground wire from each equipment rack/cabinet/frame
(installed under this work) to the TGB in the room. Each conductor is to be “home run”;
do not “daisy chain” the connections, except as may be indicated on the drawings.

2. Provide and install one individual ground wire from the overhead and vertical ladder
racking (installed under this work) to the TGB in the room. All sections of ladder rack shall
be securely connected together; otherwise, provide ground wire from each section of
ladder rack.

3. For TDMM-compliant systems: Install one individual ground wire from each TGB to the
serving electrical panel ground bus.

4. Where structural steel is available for connection install one individual ground wire to the
nearest structural steel for connection.

5. Provide and install all grounding connections as required by Telecommunications set of
drawings.

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein,
unless otherwise noted.
2. Follow the connector manufacturer’s instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:

1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition to specific labeling requirements for each conductor.

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER

E. Quantities of Ground Wires (Conductors)

1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.

2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

1. Subject to the applicable electrical code and the reference standards and guidelines, the BCT, TBB, GE conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from TIA-607-B):

<table>
<thead>
<tr>
<th>Linear Length (ft)</th>
<th>AWG Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 13</td>
<td>6</td>
</tr>
<tr>
<td>14-20</td>
<td>4</td>
</tr>
<tr>
<td>21-26</td>
<td>3</td>
</tr>
<tr>
<td>27-33</td>
<td>2</td>
</tr>
<tr>
<td>34-41</td>
<td>1</td>
</tr>
<tr>
<td>42-52</td>
<td>1/0</td>
</tr>
<tr>
<td>53-66</td>
<td>2/0</td>
</tr>
<tr>
<td>67-84</td>
<td>3/0</td>
</tr>
<tr>
<td>85-105</td>
<td>4/0</td>
</tr>
<tr>
<td>106-125</td>
<td>250 kcmil</td>
</tr>
<tr>
<td>126-150</td>
<td>300 kcmil</td>
</tr>
<tr>
<td>151-175</td>
<td>350 kcmil</td>
</tr>
</tbody>
</table>
G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.

2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.

3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):
   a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor’s documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.
SECTION 274100 - AUDIO VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. These specifications and the associated TA series drawings describe the audio-video (AV) systems (hereafter referred to as the “Technical System”) requirements to be furnished and installed as a portion of the project scope of work.

B. Work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Communications, Fire Alarm and Electronic Safety and Security Drawings and Specifications; and Addenda.

C. Work under this section of the specifications includes all labor, equipment, and installation as required to provide a complete technical system in compliance with the contract documents.

D. Employ the services of a qualified structural engineer to review all overhead mounting and suspension details of the technical system equipment. All mounting and suspension schemes indicated on the drawings are shown for concept only. Submit shop drawings stamped by a structural engineer of all details and weights for review by the project’s Architect, Structural Engineer, and Design Consultant.

E. The work in this section shall be coordinated with other work to determine installation scope for conduit, outlet boxes, junction boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables required for the technical system.

1. Provide related low-voltage “on/off” AC power control system wiring, low-voltage “on/off” control switches, and certain AC power/ground requirements internal to the equipment racks as specifically noted herein and/or on the drawings.

1.2 RELATED DOCUMENTS

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

1. Division 27 Section “General Communications Requirements”

2. Division 27 Section “Common Work Results for Communications”

B. All Category and fiber optic cabling and terminations shall adhere to the Division 27 Section “Telecommunications Requirements for Audio Video Systems”.

C. This section is a parent section to all sections numbered 274101 thru 274199. Requirements found in this section shall apply to all child sections unless otherwise noted.
1.3 EXAMINATION OF SITE

A. This project is an existing facility undergoing renovation.

B. Prior to submitting a bid personally examine the site of the proposed work and verify the conditions which involve this work.

C. By the act of submitting a bid, the contractor will be deemed to have made reasonable allowances for site examinations, site conditions, and included all costs in his proposal. Failure to verify these conditions will not be considered a basis for the granting of additional compensation.

1.4 MATERIAL AND WORKMANSHIP

A. All equipment shall be new and in proper operating condition. All workmanship shall be of the finest quality by experienced installation technicians.

B. Contact the Architect, in writing, regarding the selection of colors for all exposed equipment.

C. In addition to a complete set of the system project drawings and specifications, maintain at the job site a complete set of manufacturer’s original operation, instruction, installation, and service manuals for each equipment item, for reference.

1.5 ORDINANCE AND CODES

A. Comply with all applicable national and local codes and ordinances and obtain all required permits.

B. Contractor shall be responsible for any and all violations within the scope of this work.

1.6 DEFINITIONS

A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc

B. Suspension System – A unique assembly of rated hardware elements and accessories required for overhead installation (and attachment to building structure) of loudspeakers and other technical system components. Elements of a suspension system may include: wire rope, shackles, eyebolts, chain, beam clamps, strut channel, etc.

1.7 QUALITY ASSURANCE

A. Contractor General Qualifications:
   1. Compliance with the requirements of Division 1.
   2. Licensed to perform work of this type in the project jurisdiction.
3. At least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein.

4. Prior successful experience of projects of similar size, scope and type as outlined in the Construction Documents.

5. Active membership in the National Systems Contractors Association (NSCA).

6. Active membership in The Audiovisual and Integrated Experience Association (AVIXA).
   a. AVIXA APEX certification.

7. Fully staffed and equipped maintenance and repair facility.

8. Factory-authorized dealer for the major components specified.

B. Contractor Personnel Qualifications:

1. Skilled workers thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and the methods needed for proper performance of the work in this section. The workers shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.

   a. Minimum of one full-time staff member who has attended technical system design and installation courses taught by Syn-Aud-Con in the past 10 years.

   b. Minimum of one AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.

   c. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with and is factory-certified on the most recent version of the selected Digital Signal Processor (DSP) software and technology. This individual shall be responsible for the implementation of the DSP system including software. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.

   d. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with network-based AV transport and is factory-certified on the most recent version of the selected AV transport technology. The individual shall hold a current manufacturer’s certification (i.e., Crestron DMC-E). This individual shall be responsible for the implementation and preliminary testing of the AV transport system. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
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e. Minimum of one full-time staff member who has a minimum of three (3) years direct experience and is a factory certified Master Level Programmer on the most recent version of the AV control system software and technology. This individual shall be the same throughout the execution of the work unless illness or loss of personnel intervenes. A factory authorized independent programmer (i.e., Crestron Master CAIP) will also be accepted, providing the programmer meets the criteria identified in this paragraph.

C. Provide additional information as required for review by the Owner’s Representative, Architect, and Design Consultant to aid in proving acceptability.

1.8 SUBMITTALS

A. Refer to requirements in Division 27 Section “General Communications Requirements”.

B. Include the following items specifically as it relates to AV:

1. Submittal #1: AV System Product Data (Pre-Construction)
   a. Equipment List (1A)
   b. Manufacturers’ Cut-sheets (1B)
   c. Product Substitutions (1C)
   d. Schedule (1D)

2. Submittal #2: AV System Shop Drawings (Pre-Construction)
   a. AV Pathways, Devices, and Cabling (2A) – Follow requirements of Division 27 Section “Common Work Results for Communications”. Indicate locations of all devices and equipment.
   b. Signal Flow Shop Drawings (2B) – Any generic diagrams found within the Construction Documents shall be drawn to specific requirements. Alterations from basis of design found within the Construction Documents shall be reflected and identified. Include wire numbering scheme.
   c. AV Control System (2C) - AV control system panel/screen layouts suitable for the Owner’s Representative to understand the operation and flow (submitted no less than three months prior to system first use).
   d. DSP Signal Flow (2D) - DSP signal flow configuration (submitted no less than three months prior to system first use).

3. Submittal #3: AV System Fabrication Drawings (Pre-Construction)
   a. Structural Details (3A)
      1) No Suspended device shall be installed prior to the final approval of Structural Detail Submittals by the Consultant.
2) For Suspended equipment provide detailed, dimensioned drawings of each Suspension hardware assembly. Also indicate location relative to structure, location relative to other component(s) (Technical System or otherwise), configuration of suspended components, attachment to structure, suspension method, and calculations.

a) Calculations shall include weights of Technical System equipment including suspension hardware, and details of all suspension hardware including: manufacturer(s), part number(s) and pertinent technical information (i.e., Working Load Limit) of each part including nuts, bolts, and other accessories. All weight bearing hardware must be traceable, load rated, and domestically manufactured. All welds must be certified.

3) Prior to submission, these drawings must be approved and signed/sealed by a structural engineer licensed for the location of the project. The following guidelines are applicable:

a) Contractors participating in the Suspension of Technical System components shall conform to industry best practice standards as set forth in:

i) “Basic Principles for Suspending Loudspeaker Systems” (JBL Professional Technical Note Volume 1, Number 14); and

ii) ANSI E1.6-2 -2013 (Entertainment Technology – Design, Inspection, and Maintenance of Electric Chain Hoists for the Entertainment Industry); and

iii) ANSI E1.6-3- 2012 (Selection and Use of Serially Manufactured Chain Hoists in the Entertainment Industry).

b) All Suspended loudspeakers shall conform to ANSI E1.8-2012 (Entertainment Technology—Loudspeaker Enclosures Intended for Overhead Suspension—Classification, Manufacture and Structural Testing).

b. Equipment Rack Shop Drawings (3B) - Equipment rack front elevation for each rack showing equipment, panel layout, and electrical circuiting.

c. Panel, Patch Panel, and Plate Shop Drawings (3C) - All panel, patch panel, and plate layouts indicating locations of connectors, engraving, nomenclature, panel material, and finish. Include Structured Cabling Work required by the technical system.

4. Submittal #4: AV System Test Results (Prior to Substantial Completion)

a. Preliminary Testing Documentation Package (4A) – Provide preliminary results of system testing as described in Part 3 of this section for review prior to final acceptance. Include final results with Closeout Documentation.

5. Project Closeout
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1.9 SUBSTITUTIONS

A. Refer to Division 27 Section “General Communications Requirements”.

1.10 ELECTRONIC FILE SHARING

A. Refer to Division 27 Section “General Communications Requirements” for information on obtaining electronic versions of the construction drawings.

1.11 BASE BID AND ALTERNATES

A. In addition to the Base Bid, provide prices for designated Alternates, as defined below and as further described in the specifications and on the drawings. Alternates shall be as described herein and on the drawings. Any work not designated as an Alternate shall be provided in the Base Bid.

B. Any and all Alternates that are not accepted (i.e., not installed) shall include provisions for future installation of these Alternates. Typical provisions include engraving and installation for all panel-mounted receptacles reflecting the complete system, all wiring installed in conduit (except where conduit remains empty) with suitable identification (noted on the working drawings for inclusion with the record drawings), patch panel wiring and labeling, and appropriate rack space (including blank panels for Alternate equipment not installed).

C. The Owner's Representative reserves the right to: reject all bids; reject all Alternates; accept any Alternates in any order or combination; and determine the low Bidder on the basis of the sum of the Base Bid and accepted Alternates.

D. ADD Alternate No. 2: Revise Women's Locker Room ceiling loudspeakers as indicated per drawings.

1.12 PROTECTION OF WORK

A. Protect all work, materials and equipment from damage due to any cause. Provide for the safety and new condition of the equipment and materials until final acceptance by the Owner's Representative. Replace all damaged or defective materials and/or equipment as directed by the Architect or Design Consultant.

B. Equipment racks, cabling racks, junction boxes, termination boxes, and other exposed equipment shall be kept covered and protected from airborne contaminates. Clean all debris from the equipment room(s)/location(s) and control areas, and clean all equipment and the interior rack floor, prior to system final acceptance activities.
1.13 EXISTING EQUIPMENT

A. Certain existing technical system equipment shall be re-used with the new technical system as indicated on the drawings and in these specifications. Provide any equipment not specifically noted as “existing”.

B. Remove and store this equipment in a timely manner as required to coordinate with the project schedule. Verify all model numbers, quantities, sizes, and connector types as necessary to coordinate with system requirements. The Owner’s Representative may elect to substitute other equipment in lieu of that listed prior to the submission of shop drawings.

C. Examine the equipment and perform normal operational checks to verify that the equipment is in good condition and is operating normally. Should any equipment defects be found (physical, electrical, or otherwise), identify, in writing to the Owner’s Representative: a) defects found; and b) the estimated cost of any proposed repairs versus cost of replacement.

D. Where required for rack-mounting, furnish rack-mounting hardware or shelf for equipment not already having rack-mounting flanges. Also furnish security covers for existing equipment where such covers are required per the specifications.

E. Fully integrate the equipment with the technical system and provide all necessary signal connections and programming.

F. Proper operation and maintenance of such existing equipment remains the responsibility of the Owner's Representative.

G. The Contractor remains responsible for the removal of all existing technical system equipment that is not reused with the new system. Carefully remove all existing equipment and present to the Owner’s Representative for first right of acceptance. Dispose of all remaining equipment in accordance with all applicable environmental regulations and state and local ordinances.

H. Owner’s existing portable equipment may be used by the Owner’s Representative with the new technical systems. Proper operation and maintenance of such existing equipment remains the responsibility of the Owner's Representative.

1.14 EXISTING WIRING - REMOVAL

A. Comply with NEC (National Electrical Code) requirements regarding removal of all existing wiring that is not re-used with the system(s) defined herein.

1.15 TEMPORARY TECHNICAL SYSTEM

A. Provide and operate a temporary technical system of reasonably equivalent function as determined by the Design Consultant if the work in this section, as a failure of the contractor, is incomplete or found not in conformance with the contract documents. The temporary system shall remain in use until acceptance of the permanent system.

1.16 WARRANTY

A. Warrant all work executed under this contract, including all in-shop and onsite material, parts and labor, for a period of twelve months after the date of final acceptance.
1. Existing or any other Owner-furnished equipment shall not be included in this warranty.

2. For equipment that has an advertised manufacturer’s warranty longer than 12 months, include end date of warranty period.

B. The warranty services are limited to normal business hours, unless additional agreements are made between the Owner’s Representative and the contractor.

C. Warranty work relating to technically complex equipment and/or programming such as for codecs, digital signal processing, control systems, and video projectors shall be performed by a factory authorized technician.

D. Damage to the system resultant from improper use or adjustment by others, negligence, acts of nature, or other causes which are beyond the contractor's control shall be excluded from the warranty.

E. Visit the job two weeks prior to the end of the warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.

F. Update Record Drawings and Operation and Maintenance Data to reflect work done during Warranty period and provide the updates to the Owner’s Representative and Design Consultant.

G. Refer to General Conditions for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise designated, provide all of one type of equipment from one manufacturer; for example, microphones of one type by one manufacturer, data switches of one type by one manufacturer, cabling of one type by one manufacturer, or loudspeakers of one type by one manufacturer.

B. Equipment and wiring shown on the drawings represents the basis of design. Ensure similar or better performance is achieved by the use of equipment other than that shown.

C. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.

D. All equipment shall be new and of professional quality.

E. Some items listed in these specifications are custom-made products. Ensure when pricing and ordering equipment that the exact part number called out is used. If there is a discrepancy, contact the Design Consultant for clarification.

F. Each software programmable device furnished (i.e. Digital Signal Processor, control system, etc.) shall include most recent software and appropriate computer interface (wired cable or wireless). Cable, software, source (uncompiled) code and all related aspects of all software-controlled equipment shall become the property of the Owner and will be furnished as a portion of the
Operation & Maintenance (O&M) Data manuals (see Operation & Maintenance Manuals near the end of Part 3).

G. The quantities of each item of portable or mobile equipment (and other portable or loose accessories), as well as those items associated with Alternates, are indicated in parenthesis. Such equipment is intended to be shared between rooms having technical systems, except where noted for use in one specific room.

2.2 ETHERNET SWITCHES & ACCESSORIES

A. Ethernet switches shall be as recommended by the manufacturer(s) of the connected technical system equipment. These devices shall also be coordinated with the Owner’s Representative’s IT department to maintain common products (where possible). Each shall be labeled as shown on the technical system drawings and as required to match the Owner’s Representative’s IT labeling standard.

B. Contractor shall be responsible for the selection of product(s) that are approved for use with all systems connected to the switch(es). Products listed in this portion of the specifications are representative at the time of design – furnish the most recent approved product.

C. Ethernet switches shall have IPv4 and IPv6 routing, multicast routing, advanced quality of service (QoS), and security features in hardware. Disabling of power saving and other blocking features shall be available for proper signal traffic.

D. Ethernet switches shall be provided with all licensing requirements, product activation requirements, etc. for proper operation.

E. Ethernet switches shall be configured for proper operation of the system. Configuration shall comply with Owner’s network standards.

F. Ethernet Switch – (#)(M)(P)(G)(R)(-L3)(-AVB): Ethernet switch with SFP uplink capabilities and the following characteristics required as shown on the signal flows.

   a. ** = minimum quantity of ports
   b. (M) = managed (no symbol = unmanaged)
   c. (P) = PoE (P+ = PoE+) (no symbol = non-PoE)
   d. (*G) = 1 GB/s or 10 GB/s-capable ports as shown (no symbol = minimum 100 MB/s-capable ports)
   e. (R) = rack mount (no symbol = optional if not included)
   f. (-L) = minimum layer requirements (layer 2 or layer 3 enterprise level feature set)
   g. (-AVB) = AVB certified (no symbol = AVB capability not required)

2. Layer 2:
a. Cisco 2960X LAN Base Series; or
b. Verified equal.

3. Layer 3:
   a. Cisco 2960XR Series; or
   b. Verified equal

4. Layer 3, AVB:
   a. Cisco 3650 or 3850 series; or
   b. Verified equal.

2.3 DATA PATCH PANELS & ACCESSORIES

A. Data Patch Panels are acceptable for use in Ethernet, audio network, AVLAN, and digital multimedia network applications as required to provide a complete technical system.

B. All Category and Fiber Optic cabling (of the acceptable applications listed above) entering a technical system rack shall be terminated to a Data Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Data Patch Panel unless shown otherwise.

C. Data Patch Panels shall be labeled per specification part 3 of this section.

D. Category Cabling Patch Panels –
   1. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for product information and additional installation requirements.

E. Fiber Optic Patch Panels & Enclosures –
   1. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for product information and additional installation requirements.

F. Cable Management – 19" wide horizontal patch cable management system, 1 rack unit, with pass-through opening to allow patch cables access to rear of rack (one required per 24 port patch panel / switch):
   1. Panduit NetManager NMF1
   2. Or approved equal

2.4 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

A. Touch screen control interfaces shall follow the guidelines outlined in the “Dashboard for Controls” documents created on behalf of AVIXA International. Reference the Design Guide, Design
Reference, and Integrators Guide for this project. Documents are available for download on the AVIXA web site.

B. Contractor shall be responsible for complete configuration of the control system features including touch screen layouts, colors, appearance, operation, and coordination with systems external to the Technical System.

C. Participate in planning meeting(s) (web/phone) with Design Consultant and Owner’s Representative to review programming concepts and requirements before commencement of work.

D. Panel layout and navigational flow concepts shall be developed during planning meeting(s) with Design Consultant and Owner’s Representative. Provide mockup configurations of each interface, including layered page flow via diagram or similar.

E. Refer to submittal requirements for additional information.

F. This specification describes the initial touch screen programming concepts and requirements. Account for four (4) distinct changes for revisions requested by the Owner’s Representative after the system is substantially complete.

G. Touch screen and keypad overall user interfaces shall comply with the following minimum requirements:

1. A common theme shall be employed and used with consistency throughout the layouts. Theme shall be discussed with the Owner’s Representative. The Owner’s standard theme template shall be used if available.

2. Where Owner logos or colors are used, Owner branding guidelines shall be followed. Trademarks shall be used appropriately. Official graphical representations (logos, word marks, logotypes, etc.) may not be altered. Owner colors shall utilize official and exact color (Pantone, CMYK, RGB, hex, etc.) as provided by the Owner, visual matching is not allowed. Content shall be obtained from an official and authorized source, e.g., the use of content from Google images is not appropriate. Owner branding is encouraged where appropriate; however, proper use and compliance remains the responsibility of the Contractor.

3. The use of a password hierarchy shall be employed as directed by the Owner’s Representative as they deem appropriate.

4. Power ON/OFF sequence shall control all applicable devices. Sequence time shall be the required time for all controlled devices to cycle. Projector lamp warm-up and cool-down period shall be taken into account. Shutdown shall utilize two-step verification.

5. Animated activity indicators (spinning ring, progress bar, etc.) shall be utilized to provide visual feedback while the system is processing tasks in the background. This will prohibit multiple button presses by the user and show feedback that the control system is processing the request. Relevant text shall be utilized where appropriate, e.g., “Please wait while the system shuts down.”
6. Source selection shall be available for all devices. Sources shall be laid out and grouped in a logical manner. A ‘blank source’ or ‘image blanking’ feature shall be utilized to result in no image being displayed.

7. Button presses shall show instant visual feedback that they have been engaged and shall accurately reflect the response received from the device being controlled.

8. Current system status shall be visible at all times and be consistent across all adjoined screens. Buttons shall show current status (engaged or disengaged) via color, illumination, outline, greyscale, etc. as relevant. Sliders and level indicators shall show current and true system status (i.e. show true level based on system feedback, not status based on last touch screen input) via color, knob location, percentage, etc. as relevant.

9. All program source devices, such as Blu-ray players, shall have the control screens emulate the appearance and functionality of all operational controls of the handheld remote control or user interface furnished with each device. The furnished handheld remote control and control system shall be interoperable allowing either to be used simultaneously without causing any lockups, inconsistencies, or false control system visual status. The use of (properly vetted) manufacturer control system modules is recommended.

10. Volume control of wired microphones, wireless microphones, and/or AV system program volume levels shall be discrete and shall be properly interfaced with the DSP (where applicable). The use of a master volume control is prohibited.

11. Where applicable, show the current operation mode. For example, in the case where two rooms combine/separate, the word “Combined” or “Separated” shall be displayed on each applicable screen.

12. Control of other building systems shall be coordinated with appropriate parties. Lighting and shading systems shall be controlled via preset recall. Refer to the TA series drawings showing required interfaces.

2.5 CABLE - BULK

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.

B. Product must be procured from the original cable manufacturer.

C. AWG wire sizes indicated herein or on the drawings are the minimum size conductors required. Larger size conductors (i.e., smaller AWG number) are permitted assuming no impact on the project will occur (such as the resulting need for larger or additional conduit, cable trays, chases, etc.) to accommodate such cable.

D. Where cable is run exposed (such as in ceiling plenums, cable trays, chases, or below accessible floors):
   1. Verify which locations do and do not require plenum-rated cable.
   2. Furnish the appropriate cable type.
3. Obtain written authorization from the Architect (or the Architect’s designated Engineer) in this regard.

E. Category cabling:

1. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for product information and additional installation requirements.

F. Fiber Optic cabling:

1. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for product information and additional installation requirements.

G. Twisted Pair – Shielded: Twisted pair, shielded 22 AWG cable; interior rated 2 conductor cable with drain wire suitable for microphone, line, or production intercom level circuits:

1. Communications plenum rated cable (CMP) is suitable for use in all environments including environmental air plenums as defined per NEC Article 800.
   a. The use of performance equivalent substituted cables of lesser type is permitted at the Contractor’s discretion where allowable by NEC Article 800, local codes, and the connected equipment manufacturer’s listed requirements.
   b. Performance equivalence to the below specified products shall be determined by the cable manufacturer’s listed product equivalents provided in tables and cut-sheets.

2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.

3. 22 AWG/CMP: 22 AWG Communications Plenum rated bare copper conductor cable:
   a. Belden 9451P or 6500FC; or
   b. Clark Wire SPA22GSP; or
   c. Gepco IP222AL or 61801HS; or
   d. West Penn 25291B.

4. 22 AWG/CMR: 22 AWG Communications Riser rated bare copper conductor cable:
   a. Belden 8451 or 9451 or 5500FE; or
   b. Clark Wire SPA22GS; or
   c. Gepco IR222AL or 61801 or 61801EZ; or
   d. West Penn 291 or 452.

H. Twisted Pair – Unshielded: Twisted pair, 2-conductor interior installation loudspeaker cable:
1. Class 3 remote-control, signaling, and power-limited plenum rated cable (CL3P) is suitable for use in all environments including environmental air plenums as defined per NEC Article 725.
   a. The use of performance equivalent substituted cables of lesser type is permitted at the Contractor's discretion where allowable by NEC Article 725, local codes, and the connected equipment manufacturer's listed requirements.
   b. Performance equivalence to the below specified products shall be determined by the cable manufacturer's listed product equivalents provided in tables and cut-sheets.
   c. Wire gauge shall not be reduced to gain a higher cable rating.

2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.

3. ** AWG/CL3P: As listed AWG Class 3 Plenum rated bare copper conductor cable:
   a. Belden 1862A or 6200UE (16 AWG), 6300UE (18 AWG); or
   b. Gepco IP122BA19 (12 AWG), IP142BA19 (14 AWG), IP162BA19 (16 AWG), IP182BA7 (18 AWG); or
   c. West Penn 25210 (10 AWG), 25227B (12 AWG), 25226B (14 AWG), 25225B (16 AWG), 25224B (18 AWG).

4. ** AWG/CL2P: As listed AWG Class 2 Plenum rated bare copper conductor cable:
   a. Belden 6T00UP (10 AWG), 1860A or 6000UE (12 AWG), 1861A or 6100UE (14 AWG), 1863A (18 AWG); or
   b. Clark Wire CW1202P (12 AWG), CW1402P (14 AWG), CW1602P (16 AWG), CW1802P (18 AWG).

5. ** AWG/CL3R: As listed AWG Class 3 Riser rated bare copper conductor cable:
   a. Belden 5000UE (12 AWG), 5100UE (14 AWG), 5200UE (16 AWG), 5300UE (18 AWG); or
   b. Clark Wire CW1202HS (12 AWG), CW1402HS (14 AWG); or
   c. Gepco IR122BA19 (12 AWG), IR142BA19 (14 AWG), IR162BA19 (16 AWG), IR182BA7 (18 AWG); or
   d. West Penn 227 (12 AWG), 226 (14 AWG), 225 (16 AWG), 224 (18 AWG).

6. ** AWG/CL2R: As listed AWG Class 2 Riser rated bare copper conductor cable:
   a. Clark Wire CW1202 (12 AWG), CW1402 (14 AWG), CW1602 (16 AWG), CW1802 (18 AWG).
7. ** AWG/CL3: As listed AWG Class 3 rated bare copper conductor cable:  
   a. Belden 1313A (10 AWG), 1311A (12 AWG), 1309A (14 AWG), 1307A (16 AWG); or  
   b. Gepco 122HBW (12 AWG), 142HBW (14 AWG).

8. ** AWG/CL2: As listed AWG Class 2 rated bare copper conductor cable:  
   a. Belden 5T00UP (10 AWG); or  
   b. West Penn HA210 (10 AWG).

I. RG-59: Single 75-ohm coax, RG-59/U precision video cable:  
   1. RG-59/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:  
      a. Belden 1505A; or  
      b. Clark Wire CD7559; or  
      c. Gepco VPM2000; or  
      d. West Penn 819.  
   2. RG-59/P: Plenum rated cable:  
      a. Belden 1506A; or  
      b. Clark Wire CD7559P; or  
      c. Gepco VPM2000TS; or  
      d. West Penn 25819.  
   3. RG-59/Flex: Non-plenum flexible cable, for use with portable cables, exposed, or other locations where cable movement can or does occur:  
      a. Belden 1505F; or  
      b. Clark Wire CD7559F; or  
      c. Gepco VHD2000M.

J. RG-6: Single 75-ohm coax, RG-6/U precision video cable:  
   1. RG-6/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:  
      a. Belden 1694A or Gepco VSD2001; or
b. Belden 1694wb (outdoor water block); or

c. Clark Wire CD7506; or

d. Clark Wire CD7506DB (direct burial, water block); or

e. West Penn 6350.

2. RG-6/P: Plenum rated cable:

   a. Belden 1695A; or
   b. Clark Wire CD7506P; or
   c. Gepco VSD2001TS; or
   d. West Penn 256350.

K. RG-11: Single 75-ohm coax, RG-11/U precision video cable:

   1. RG-11/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

      a. Belden 7731A; or
      b. Clark Wire CD7511; or
      c. Gepco VHD1100; or
      d. West Penn 1135.

   2. RG-11/P: Plenum rated cable:

      a. Belden 7732A; or
      b. Clark Wire CD7511P; or
      c. Gepco VHD1100TK.

L. RG-58: Single 50-ohm coax, RG-58/U radio frequency cable:

   1. RG-58/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

      a. Belden 7806R; or
      b. Clark Wire CV5058; or
      c. West Penn 812.

   2. RG-58/P: Plenum rated cable:
M. RG-8: Single 50-ohm coax, RG-8X and RG-8/U radio frequency cable:

1. RG-8X/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
   a. Belden 7808R or 9258; or
   b. Clark Wire CV5008X; or
   c. Gepco V5020; or
   d. West Penn 807.

2. RG-8X/P: Plenum rated cable:
   a. West Penn 25810.

3. RG-8/U/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
   a. Belden 9913; or
   b. Clark Wire RF50LL; or
   c. West Penn 810.

4. RG-8/U/P: Plenum rated cable:
   a. Belden 89913; or
   b. Clark Wire RF50LLP; or
   c. West Penn 25812.

N. RG-213: Single 50-ohm coax, RG-213/U radio frequency cable:

1. RG-213/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
   a. Belden 8267; or
   b. Clark Wire CV50213.

O. RS-232: Low capacitance computer cable for EIA RS-232/422, 24 AWG, 4-conductor, shielded, minimum conductor-to-conductor capacitance: 22pF/ft, PVC jacket:
1. RS-232/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
   a. Belden 8102; or
   b. Clark Wire SMP2404.
2. RS-232/P: Plenum rated cable:
   a. Belden 88102; or
   b. Clark Wire SMP2404P.

2.6 CABLES – FACTORY TERMINATED – INSTALLED

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this subsection does not indicate a requirement for use.

B. Factory terminated cable assemblies specified in this subsection are only permitted for use within racks or between devices external to racks. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Not permitted for use in conduit unless specifically noted as such.

C. Factory terminated cable assemblies shall be the minimum length needed to accomplish the connection. Portable cable assemblies are specified in Division 27 Section “Audio Video Systems Equipment” and are required to be furnished in addition to those required for system installation.

D. All cable assemblies must be factory tested and certified.

E. Category cabling:
   1. Refer to Division 27 Section “Telecommunications Requirements for Audio Video Systems” for product information and additional installation requirements.

F. Fiber Optic cabling:
   1. Refer to Division 27 Section “Telecommunications Requirements for Audio Video Systems” for product information and additional installation requirements.

G. DisplayPort, version 1.1a or higher, Acceptable lengths: 1’-25’:
   1. Clark Wire DP Series (3’, 6’, 10’, 15’); or
   3. Extron DisplayPort M-M Series (3’, 6’, 12’, 25’); or
   4. Approved Equal.

H. DVI, Dual Link DVI-D cable, Acceptable lengths: 1’-16’:
1. Clark Wire DVID Series (3’, 6’, 10’, 16’); or
2. Comprehensive Pro AV/IT Series (3’, 6’, 10’, 15’); or
3. Extron DVID DL Pro Series (3’, 6’, 12’); or
4. West Penn CN-E08 Series (6’, 10’, 15’); or
5. Approved Equal.

I. DVI-Flex, Flexible Single Link DVI-D cable, Acceptable lengths: 1’-16’:
   1. Comprehensive MicroFlex Low Profile Series (1.5’, 3’, 6’, 10’, 15’); or
   2. Extron DVID SL Ultra Series (1.5’, 3’, 6’, 9’, 12’); or
   3. Approved Equal.

J. HDMI Locking Cable, version 1.4 or higher compliant, locking connectors, male HDMI to male HDMI, Acceptable lengths: 1’-25’:
   1. Belden HD-800 Series (2’, 4’, 8’, 25’); or
   2. Clark Wire HDMI-L Series (3’, 6’, 10’, 16’); or
   3. Perfect Path 800 Series (2’, 4’, 8’, 16’, 25’); or
   4. Approved Equal.

K. HDMI Fiber Optic Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 25’-328’:
   2. Liberty DL-HDM-M-***M Series (8m, 10m, 15m, 23m, 30m, 50m, 60m, 100m); or
   4. Approved Equal.

L. USB, Type B male (device = square) to Type A male (computer = flat) or Type A male to Type A male USB 2.0 compliant, Acceptable lengths: 1’-25’:
   1. Comprehensive; or
   2. Extron; or
   3. Approved Equal.

M. Video Cable BNC, RG-59 BNC to BNC, 75 ohm, Acceptable lengths: 1’-25’:
1. Canare VAC Series (3’, 5’, 25’); or
2. Comprehensive Pro AV/IT Series (3’, 6’, 10’, 25’); or
3. Hosa BNC-59-1 Series (3’, 5’, 25’); or
4. Whirlwind VID BNC3 Series (5’, 25’); or
5. Approved Equal.

2.7 CONNECTORS

A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.

B. All XLR receptacles located outdoors, in boxes that are located outdoors, in natatoriums, or in areas where moisture or other corrosive materials are present shall have gold plated contact pins.

C. XLR Cable Connector, cable mounted connector for line-level, microphone level, and intercom circuits:
   1. Amphenol AC series; or
   2. Neutrik X-series; or
   3. Switchcraft E Series Q-G.

D. XLR Panel Connector, panel mounted audio connector for line-level, microphone level, and intercom circuits, color shall match plate color where possible:
   1. Amphenol AC “DZ” series; or
   2. Neutrik D-Series; or
   3. Switchcraft standard AAA Series Q-G with metal handle.

E. XLR Combo Connector, female XLR and 1/4” TRS receptacle in one chassis-mount connector:
   1. Neutrik NCJ6FI-S.

F. 1/4” TRS Cable Connector, three-conductor (Tip Ring Sleeve) connector with a metal barrel and solder lugs:
   1. Amphenol TS3PN; or
   2. Canare F-16; or
   3. Neutrik NP3C; or
   4. Switchcraft 267.
G. 1/4" TS Cable Connector, two-conductor (Tip Sleeve) connector with a metal barrel and solder lugs:
   1. Amphenol TM2PN; or
   2. Canare F-15 plug; or
   3. Neutrik NP2C plugs; or
   4. Switchcraft 250.

H. 1/4" TRS Panel Connector, three-conductor (Tip Ring Sleeve) connector with the sleeve contact isolated from the panel or plate to which it is mounted:
   1. Neutrik NJ3FP6C; or
   2. Switchcraft E112BL.

I. 1/8" TRS Cable Connector, 1/8" (3.5mm) three-conductor mini-plugs which have a metal barrel and solder lugs:
   1. Amphenol KS3P; or
   2. Canare F-12; or
   3. Neutrik NTP3RC; or
   4. Switchcraft 35HDNN plug.

J. Locking LS Cable Connector, twist-lock cable mount male loudspeaker connector, minimum 2-two conductors. Coordinate connector with associated intended panel mount connector, including those on loudspeakers:
   1. Amphenol SP-2-FN (two conductor); or
   2. Neutrik speakON NL2FC (two conductor); or
   3. Amphenol SP-4-FN (four conductor); or
   4. Neutrik speakON NL4FC (four conductor); or
   5. Neutrik speakON NL8FC (eight conductor).

K. Locking LS Panel Receptacle, twist-lock chassis mount female loudspeaker connector, minimum two conductors. Coordinate receptacle with associated intended cable connector:
   1. Amphenol SP-2-MD (two conductor); or
   2. Neutrik speakON NL2MP (two conductor); or
   3. Amphenol SP-4-MD (four conductor); or
4. Neutrik speakON NL4MP. Male connector (four conductor); or
5. Neutrik speakON NL8MPR-BAG (eight conductor)

L. RJ45 Panel (Faceplate) Connector-6, data connector rated for shielded Category 6 cable:
   1. Neutrik etherCON NE8FDY-C6* with SCDX cover

   *Division 27 “Telecommunications Requirements for Audio Video Systems” Contractor shall terminate cable onto etherCON connector installed in custom faceplate.

M. BNC Cable Connector, 75-ohm BNC, compression fitting for coaxial cable furnished:
   1. Liberty CM-RG-BNC series; or
   2. West Penn CN-CS-BNC and CN-FS-BNC series.

N. BNC Panel Connector, 75-ohm BNC, pass-through, D-style mounting:
   1. Neutrik NBB75DFI; or
   2. Approved Equal.

O. Terminator, RF or SDI terminator plug:
   1. Extron T-BNC series; or
   2. Pomona 3840 series; or
   3. Trompeter TNA series.

P. Captive Screw Terminal Block, modular terminal blocks for mounting on DIN rails:
   1. Entrelec Screw Clamp series; or
   2. Approved Equal.

2.8 EQUIPMENT RACKS

A. Furnish complete equipment racks including all top, bottom, and sides as necessary.

B. Furnish all necessary accessories including ganging hardware, blank plates (to fill all unoccupied space), vent panels (as applicable), shelves, security covers, mounting screws, trim kits, lacing bars, cable management, leveling feet, casters, etc. to provide a complete solution which complies with “best practice” guidelines.

   1. Full-solution accessories are not detailed in this specification. They shall be provided as needed and shall be approved by the manufacturer for use with the intended rack series (i.e. Middle Atlantic casters must be used with a Middle Atlantic rack).
C. Furnish all required components for a complete thermal management solution within each location to ensure enclosure interior temperature does not exceed manufacturer’s recommended operating temperatures.
   1. Rack fans shall be quiet, such as the Middle Atlantic QFAN.
   2. Thermostatic fan control shall be utilized where available.

D. Furnish all required components for a complete rack ground isolation solution.
   1. Racks shall be isolated from the floor by the use of isolated leveling feet (such as Middle Atlantic LF-ISO) or an isolation pad/system (such as Middle Atlantic ISO-1).

E. Equipment racks and all associated blank panels located in equipment rooms shall be factory finished semi-gloss black. Equipment racks and associated blank panels located in control booths or other visible locations shall be factory-finished color as selected by the Architect.

F. Furnish locking storage drawers, hinged security covers, and racks with locking doors all keyed alike. Furnish four keys total.

G. Equipment rack specification indicates the system basis of design. Verify equipment layout, rack size, and number of equipment racks required for equipment furnished. “***” in part number denotes rack height.

H. Floor Rack:
   1. SA – XD, stand alone floor rack, rear locking door, minimum 44RU height, minimum 32” extra deep:
      a. Lowell LER-4432; or
      b. Middle Atlantic Products BGR-45SA-32; or
      c. Middle Atlantic Products WRK-44SA-32.

2.9 EQUIPMENT RACK ACCESSORIES

A. The following equipment rack accessories shall be provided as indicated on the rack elevations or within this section.

B. Equipment rack accessories located in equipment rooms shall be factory finished semi-gloss black. Equipment rack accessories located in control booths or other visible locations shall be factory-finished color as selected by the Architect.

C. Logo rack panel, single vertical rack space, labeled with contact information for the contractor and Design Consultant. Panel specified is custom and already has the information for the Design Consultant; the contractor shall coordinate their logo/information with the panel manufacturer (shop drawing required). One required to be installed at the top of each bank of equipment racks:
   1. Liberty AV Solutions model HEI-RHIM-TEMPLATE.
D. Storage drawer, specification indicates the system basis of design. "***" in part number denotes (RU) height as indicated in rack elevations.

1. Locking rack drawer keyed to match rack rear door, approximately 16" deep, color to match adjacent rack-mounting panels:
   a. Atlas Sound SD**-14 with optional SD-LOCK installed; or
   b. Middle Atlantic D**-LK; or
   c. Chief SDR-**-L.

2. Rack drawer, approximately 16" deep, color to match adjacent rack-mounting panels:
   a. Atlas Sound SD**-14; or
   b. Middle Atlantic D**; or
   c. Chief SDR-**.

E. Rack Shelf:

1. 1RU, utility rack shelf, 3.5" high, approximately 10" deep, color to match adjacent rack-mounting panels:
   a. Atlas Sound SH1-10; or
   b. Lowell 1556-USV110; or
   c. Middle Atlantic UTR1.

2. 2RU, utility rack shelf, 3.5" high, approximately 16" deep, color to match adjacent rack-mounting panels:
   a. Atlas Sound SH2-15; or
   b. Lowell 1556-USV110; or
   c. Middle Atlantic U2.

2.10 AC POWER

A. General

1. A complete AC power connection solution for each equipment rack and cabinet is required.

2. Provide spare NEMA 5-15R or 5-20R outlets (single duplex receptacle) for temporary equipment (beyond that required for connected equipment, rack fan, etc.). These outlets shall be fed from an un-switched “Normal” power circuit.
   a. For racks 16 RU or less: two spare outlets (minimum)
b. For racks greater than 16 RU: four spare outlets (minimum)

3. All power strips shall maintain integrity of system grounding requirements.

4. All equipment shall be connected such that maximum rated performance can be obtained without exceeding the AC circuit load capacity.

5. Coordinate with Electrical drawings and Division 26 specifications. Where outlets are provided under this section as a portion of power strips or power distribution units, receptacle types and colors shall match the supplied AC power circuit.

6. Comply with all NEC requirements, including separation of loads classified as Life Safety from Normal loads via an independent Vertical / Horizontal Power Strip, PDU, and/or UPS.

B. Uninterruptable Power Supply Requirements

1. UPS shall be provided in quantities as indicated on signal flows and/or rack elevations, and as described for components and equipment within this Section and associated Subsections.

2. A UPS connected to a Normal power load shall be provided with enough battery capacity to bridge short duration loss of power and brownout events. The intent is to protect and prolong the life of sensitive processor based equipment, reduce power cycle time upon restoration of Normal power, and/or allow the User time to safely shut down components.

3. A UPS connected to Emergency (NEC Article 700), Legally Required Standby (NEC Article 701), or Optional Standby (NEC Article 702) AC power circuits shall be provided with enough battery capacity to bridge the maximum operation load of the connected equipment during the time from loss of Normal power to load handover to the electrical standby power system (typically generator startup time).

4. Each UPS with an ethernet port shall be connected to the network. The Contractor shall configure the UPS (using additional software where required) per direction from the Owner’s Representative. Configuration shall include, but not be limited to:
   a. Remote access and diagnostics
   b. Automated reporting for non-normal events (such as battery condition or power interruption)

C. PS/V: Vertical Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum fourteen NEMA 5-15R outlets, mount to rear of rack interior (furnish where provided electrical receptacle quantities do not meet system requirements):

1. APC AP7530 with 40170-6INCH L5-20P adaptor; or

2. Eaton EPBZ97; or

3. Middle Atlantic PD-2420SC-NS; or

4. Tripp Lite PDUV20 with included L5-20P adaptor; or
5. Approved equal.

D. PS/H: Horizontal Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum eight rear-facing NEMA 5-15R outlets, single rack space (furnish where provided electrical receptacle quantities do not meet system requirements):

1. APC AP9563; or
2. Eaton EPBZ85; or
3. Middle Atlantic PD-920R-NS; or
4. Tripp Lite PDU 1220; or
5. Approved equal.

E. PDU/V: Vertical Power Distribution Unit, capable of multiple circuits and outlets, configured for circuit quantity, voltage, and amperage provided to rack; mount to rear of rack interior (furnish in coordination with provided electrical power):

1. Juice Goose PD Series; or
2. Middle Atlantic MPR Series; or
3. Middle Atlantic PDW Series; or
4. Approved equal.

F. UPS:

1. 1RU: Uninterruptable Power Supply, single rack space chassis, line interactive, surge suppression, 120V 20A circuit, minimum 750VA load, plug input, minimum four rear-facing NEMA 5-15R outlets:
   a. APC Smart-UPS SUA750RM1U; or
   b. Eaton 5P750R; or
   c. Middle Atlantic UPS-S1000R; or
   d. Tripp Lite SmartPro SMART750RM1U; or
   e. Approved equal.

2. 2RU: Uninterruptable Power Supply, two rack space chassis, line interactive, surge suppression, 120V 20A circuit, minimum 1950VA load, plug input, minimum eight rear-facing NEMA 5-15R outlets:
   a. APC Smart-UPS SMT2200RMUS; or
   b. Eaton 5P2200RT; or
c. Middle Atlantic UPS-2200R-8IP; or

d. Tripp Lite SmartPro SM2200RMXL2UP; or

e. Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 PREPARATION

A. Coordinate locations and sizes of junction boxes, outlets, and conduit with the work of other trades. Field verify compliance with the construction documents.

B. Carefully inspect areas where equipment will be installed. Notify the Architect of any conditions that would adversely affect the installation and subsequent operation of the system.

1. Repeat inspection on a regular basis to ensure ongoing work by other trades does not pose a conflict to Contractor's pending work.

3.3 INSTALLATION

A. General

1. Contractor shall demonstrate a reasonable standard of care. Installation shall be rendered in a workmanlike manner observing direction set forth herein as well as industry standard best practices.

2. In addition to any spare cabling shown on drawings, utilize industry best practice to pull additional spare cabling in conduit where logical. Neatly bundle a usable length of cable at each end of each spare circuit. All spare circuits shall be labeled and noted on the field drawings for inclusion into the record drawings.

3. Install any floor-mounted receptacles so that release buttons (for both receptacles and cable connectors) are easily accessible when cable connectors are installed.

4. Blank panels and/or vent panels shall be installed in unused rack spaces. Ensure that air flow within the rack is maintained (i.e. cool air can enter the rack and hot air can exit the rack).

5. Equipment racks and other exposed equipment shall be kept covered and protected from airborne contaminates. Clean all equipment racks and the interior rack floor, prior to system final acceptance activities.

6. For racks installed in credenzas, fasten carpet tiles or low friction sliders to the bottom of the rack to protect the finish of the furniture.
7. Where the design location requires products, materials, or equipment to be visible to the public, manufacturers logos shall be removed if possible. Unless otherwise directed, neatly remove or logos.

8. AC power switches located on the front panel of equipment mounted in racks shall be covered by a security cover or utilize front panel lockout features. Exclusions from this list are items requiring user interface such as tuners and wireless microphone receivers.

9. Furnish all equipment with factory finish where possible using the standard available factory color(s) as selected by the Architect. Notify the Architect regarding color options of relevant equipment prior to ordering equipment from each manufacturer.

B. Suspended Systems

1. General
   a. Contractor shall provide Suspension system, including connection to structure, for all suspended components including but not limited to: loudspeakers, video projectors, flat panel displays, televisions, projection screens, etc.
   b. Suspension system design shall be created by the Contractor and include fully dimensioned detail documentation stamped by a structural engineer licensed in the location of the project per submittal requirements in Part 1 of this document.
   c. Contractor shall include a safety cable or other backup support mechanism.
   d. Suspension systems and installation shall conform to industry best practice standards as set forth in:
      1) “Basic Principles for Suspending Loudspeaker Systems” (JBL Professional Technical Note Volume 1, Number 14)
   e. Coordinate with General Contractor any supplemental building structure necessary to facilitate the approved suspension design.
   f. Field verify conditions for compliance with the approved suspension plan prior to installation, placement of equipment orders, or material fabrication. Coordinate with other trades as necessary.

2. Loudspeakers
   a. Install loudspeakers so there are no obstructions to loudspeakers’ coverage pattern.
   b. Loudspeakers shall be installed such that they do not produce or cause mechanical rattles in the surrounding structure. There shall be no audible vibration or noise caused by improper mechanical installation or defective components.
   c. Paint loudspeaker and/or grille assembly (at discretion of Architect or Design Consultant) color as selected by the Architect. Use primer per manufacturer’s recommendations. Do not paint loudspeaker cones or high frequency diaphragms. Materials and labor provided by Contractor.
d. Provide access to loudspeakers during installation, testing, and final acceptance activities to allow for modifications to location or installation. Access includes all necessary resources required to obtain direct physical contact to loudspeakers (front and rear), including: scaffolding, motorized lift, etc.

e. Provide ability to reorient loudspeakers in all axes (yaw, pitch, and/or roll) if so requested by Design Consultant during system final acceptance activities.

1) Do not perform final suspension connections prior to final acceptance by the Design Consultant including: permanent cable swage, elimination of wire rope service loop, etc.

C. Video

1. Coordinate structural backing required for wall mounted flat panel displays/televisions prior to the installation of drywall or other wall materials.

D. Grounding

1. Comply with NEC and BICSI grounding requirements.

2. Each equipment rack within a row of racks and each row of racks within a room shall be electrically bonded to each other. Bonding shall be via copper ground bus. Any bolts shall fasten to unpainted sheet metal.

E. Equipment Power Control

1. Low-voltage "ON/OFF" control of system equipment shall be provided via the control system.

2. Operation of the following components is required, at a minimum:

a. Power amplifiers as indicated in Part 2 requirements

b. UPS connected devices where components do not require power under system shutdown

c. Components equipped with power state control

3. Make all low-voltage connections as required to provide a complete and working control system.

4. Refer to drawings for additional low-voltage sequencing system requirements.

5. Refer to electrical drawings for AC power information.

6. Coordinate with Electrical Contractor as necessary to verify proper circuit assignment and sequencing order.
3.4 RACK BUILDING, CABLE MANAGEMENT AND TERMINATION

A. Employ techniques to fulfill AVIXA F502.01:2019 “Rack Building for Audiovisual Systems” as a minimum standard with the additional requirements as described in this paragraph.

B. General

1. Do not violate the minimum cable bend radius as specified by the cable manufacturer.

2. Dress cables so terminations are free from stress due to gravity acting on the cabling. Use cable supports as required depending on the size and stiffness of the cable.

3. Terminate cables with sufficient service loop to allow at least one re-termination without having to open a cable bundle or pathway.

4. All circuits, including various audio signal levels, shall be separated according to function. Where audio and video circuits are installed in conduit or other raceway, separate conduits are required for the various circuit functions.

5. Where circuits are exposed in the equipment racks or large junction or pull boxes, circuits shall be bundled according to function. Refer to “Conduit/Circuit Group Divisions” and “Conduit Routing and Separation” schedules for additional information.

6. All solder connections shall be made with soldering iron and rosin core solder. All solder connections shall be checked for "cold" solder joints.

7. If equipment is removed or replaced for service, ensure the proper cable termination points are apparent when the equipment is re-installed.

C. Equipment Racks

1. Use Velcro tie wraps for dressing cables within the rack(s), hand tightened and spaced at various inconsistent distance intervals.

2. Do not use zip ties for UTP cables or any in-rack cables.

3. When dressing cables within the rack, do not tighten tie wraps so the cable is deformed.

4. Install rack-mounted equipment manufactured without IEC removable power cords so the power cords are dressed using removable fasteners such as Velcro and there are no obstructions to the item being pulled out from the front of the rack. Avoid coiled or bundled cable loops.

5. For rack-mounted equipment manufactured with IEC removable power cords, provide power cord assemblies of the minimum length needed to accomplish connection to the PDU. Avoid excess power cabling including coiled or bundled cable.

6. Factory terminated cable assemblies are only permitted for use within racks, between devices external to racks, as portable equipment, or for use in conduit as specifically noted as follows: Permitted for rack inter-connect when racks are in close proximity (same room).
and may pass thru conduit if necessary in this situation. Cable assemblies shall be the minimum length needed to accomplish the connection.

7. Install rack equipment to enable repair or replacement without hindrance. If there are obstructions prohibiting the disconnection of terminations on the back side of the technical equipment, there must be sufficient cabling to permit the equipment to be pulled from the front allowing for easy disconnection and reconnection.

D. Paralleling and Extension Connections

1. Circuits shall not be joined by butt-splice, solder-splice, wire nut, or similar.

2. Circuits requiring parallel connection as indicated on signal flows shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
   a. Approved connections include DIN mounted terminal blocks as specified in Part 2.
   b. Field splicing techniques such as wire nuts, “twist and solder”, etc. are not allowed.
   c. Any circuit requiring parallel connection shall be permanently labelled on every cable as defined herein.
   d. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.

3. Circuits requiring extension (non-data) due to field conditions such as excessive conduit bends, etc., shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
   a. Extension of circuits is to be avoided if at all possible.
   b. Contact the Design Consultant via documented project communication. Inform the Design Consultant of the circumstances regarding the desired extension. Contractor and Design Consultant will coordinate to determine the most appropriate course of action.
   c. Approved connections include DIN mounted terminal blocks as specified in Part 2.
   d. Any circuit requiring extension shall be permanently labelled on every cable as defined herein.
   e. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.

4. Document each parallel connection and extension on the field drawings and transfer same to the final record drawings.

E. Telecommunications Cabling
1. Refer to Division 27 Section “Telecommunications Requirements for Audio Video Systems” for all work associated with data-related cabling including Category and Fiber Optic cabling.

2. All data-related cabling entering a rack shall be terminated to a Data Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Data Patch Panel.

3. All Fiber Optic cabling entering a rack shall be terminated to a Fiber Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Fiber Patch Panel.

F. Microphone/Line Level Audio

1. Audio circuit termination shall observe the methods set forth in “Sound System Interconnection” RaneNote 110, © 2011 by Rane Corporation. This reference document may be obtained at: http://www.rane.com/pdf/ranenotes/Sound_System_Interconnection.pdf

2. Key methods include, but are not limited to the following:
   
a. All audio circuits shall be balanced two-wire circuits, with a separate grounding shield conductor, unless noted otherwise. All circuits shall have either the red or white wires as the "high" or "+" side of the line and connect to pin 2 of microphone-type XLR audio connectors and the tip of 3-conductor phone connectors. The black wire of the two-wire circuit shall be the "low" or "−" side of the line and connect to pin 3 of microphone connectors and the ring of 3-conductor phone connectors. The shield conductor shall connect to pin 1 of microphone connectors or to the sleeve of phone connectors.

   b. Shield conductors shall be connected at each end of each wire to the pin 1 of each XLR, shield connection for each electronic device, etc. No shield wires shall be left unconnected except where noted on the drawings, nor shall any shield come in contact with conduit, pull boxes, or other building steel. Audio line-level circuit shield wires shall be grounded to rack sheet metal only via rack-mounted equipment. Shields shall be electrically isolated in multi-conductor cables. Shields for audio line-level circuits connected to audio transformers shall be connected to transformer electro-static shields and case ground.

   c. In the case of an unbalanced source feeding into a balanced input and the cable run is short (i.e. less than fifteen feet), connect the signal connection of the unbalanced connector to the "high" side of the balanced input. Connect the "ground" connection of the unbalanced line to the "low" side of the balanced connector. Connect the cable shield to the shield connection of the balanced input but do not connect it to the unbalanced connector. If the cable run is longer than fifteen feet, balance the line at the unbalanced source using specified balancing devices.

   d. In the case of a balanced source feeding into an unbalanced input and the cable run is short (i.e. less than fifteen feet), connect the "high" side of the balanced output to the signal input of the unbalanced connection. Connect the "shield" of the balanced connection to the "ground" of the unbalanced connection. Leave the "low" side of the balanced output floating.
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G. Loudspeaker Level Audio
   1. Loudspeakers in the same acoustic space shall all be wired to produce consistent polarity with a mono input signal. They shall also be polarized such that a positive acoustic pressure on a microphone results in a positive acoustic pressure at all loudspeakers.

H. Video
   1. Compression fittings shall be used for all BNC and F connector terminations.
   2. Terminate all unused RF and SDI outputs with impedance matching terminators.
   3. Neatly dress all cables behind a flat panel display/television. Cables and connections should not be visible from the viewing locations. Power cables for displays shall not be bundled with signal cables nor visible.
   4. For fixed projector or pole mounted flat panel display installations, signal cables shall be routed within the mounted pipe. Signal cables shall not be tied to the outside of the pipe. Provide cabling of appropriate distance to minimize excess cable at device. Bundle excess cable above the ceiling, not at the device.

3.5 LABELING
   A. Adhere to AVIXA F501.01:2015 “Cable Labeling for Audiovisual Systems” as a minimum standard with additional requirements as described in this paragraph.
   B. Refer to Division 27 Section “Telecommunications Requirements for Audio Video Systems” for all labeling requirements associated with data-related cabling including Category and Fiber Optic cabling.
   C. Develop and utilize a consistent numbering scheme across the entire project. Utilize system names and building references where applicable, such as the rack number or rack room in a distributed system. All labels for input/output plates and control panels shall be consistent with the final room numbering for the facility.
   D. Adhere to the labeling standard across all platforms, including within the DSP programming.
   E. Refer to general notes, the signal flows, and panel and plate details for expected labeling scheme of system equipment and components. Comply with any specific color coding as described.
   F. All equipment in equipment racks shall be labeled front and rear for ease of identification. Labels shall be of a contrasting color with that of equipment color to promote visibility.
   G. Install permanent labeling on the front of each equipment rack in a row of racks identifying the rack designation (number).
   H. Within each rack and at other remote locations for technical system equipment, label all associated AC power receptacles reflecting the appropriate circuit breaker. Ensure that the circuit breakers are labeled as to the rack or remote equipment location.
   I. Document the labeling standard for inclusion in the Operation and Maintenance Data.
J. Document all labels for the Record Drawings.

K. Pre-approved labelling systems include:
   1. Brother P-touch EDGE with HGeS2***PK labels; or
   2. Brady Equipment Identification Labels.

3.6 SYSTEM CONFIGURATION

A. Coordination
   1. Coordinate and take responsibility for the approval of all system configuration components as described in this paragraph.
   2. Coordinate all aspects of the technical system network, including configuration and connection with to the Owner's LAN. Utilize Owner's designated configuration style, standards, and security requirements.

B. Software
   1. Furnish, install, and configure the most recent approved, non-beta, software for each device or system.
   2. Provide software as identified in other areas of these specifications or on the drawings.
   3. Provide software not specifically identified but required to allow for system operation and/or to allow for more efficient system configuration, setup, and operation.

C. Firmware
   1. Ensure the firmware for each device is the most recent manufacturer approved version and is installed and operational.

D. Operating Systems
   1. Gain approval of the operating system version and type from the Owner’s IT representative and associated equipment manufacturer(s).
   2. Ensure the operating system for each device is the most recent, installed, and fully operational.
   3. Ensure the latest security patches are installed.

E. Network Configuration
   1. All technical system devices with an Ethernet port shall be connected to the associated network.
2. Secure the entire network, documenting all passwords. Comply with the Owner’s IT representative’s requirements with respect to password selection and network security implementation.

F. Network Documentation

1. Document the IP and MAC addresses of all IP capable equipment for inclusion with the Operation & Maintenance Manuals.

3.7 CONTRACTOR’S TESTING, ADJUSTMENT, AND SUBMITTAL REQUIREMENTS

A. At the completion of the installation, perform the following tests on the system to ensure proper installation and operation. The technical system shall be fully tested with all equipment on site, installed, connected, and fully operational.

B. Adhere to ANSI/Infocomm 10:2013 “Audiovisual Systems Performance Verification” as a minimum standard with additional requirements as described in this paragraph.

C. The Contractor shall submit the results of all tests prior to on-site system review by the Design Consultant. Where available, provide documentation obtained directly from the test equipment. Other acceptable documentation includes screen captures, photos, and spreadsheets.

D. General

1. Utilize the technical support services offered by the manufacturers of the various technical system components to ensure optimum performance.

2. All test equipment used for these tests shall be on site during the system final acceptance activities should verification of submitted measurements be required.

3. Ensure that all equipment is on the job-site and fully operational. This includes portable (not installed) items and other loose equipment. Remove all devices from shipping or packaging containers, ready for use, and place in equipment storage cabinet.

4. The functional tests shall include operational tests of all program source equipment (record and playback), wireless microphone system, mixing console, system inputs and outputs, all patch panel receptacles, intercom system, video routing, video distribution, operational controls, AC power sequencing, operation of software, and all system electronics. Functional tests include examination for hum, buzz, hiss, ghosts, hum bars, oscillation, thumps, unintended reception of other signals such as AM or FM radio, TV, CB, ham radio, cell phones, or any other unwanted signals through the system.

5. Ensure all inputs and outputs are wired to the appropriate devices per construction documents.

6. Verify system startup and shutdown operates in the proper sequence.

   a. System head end components shall be energized at the beginning of the startup sequence in an appropriate order to guarantee proper communication will associated devices.
b. Loudspeaker power amplifiers shall be energized at the end of the sequence in order to eliminate unwanted transients being reproduced through system loudspeakers.

c. System shutdown sequence shall be in reverse order.

7. Where a system computer is furnished, load and configure all necessary control software. Examples include but are not limited to the following as applicable: wireless microphone management, amplification management, projector/display management, audio console configuration/control, DSP configuration/management, and active loudspeaker management.

8. Where audio or video digital signal transport is required, ensure all network setup is complete including the installation and licensing of network management application software.

E. Required testing equipment

1. Certain systems/subsystems require testing and documentation via approved test equipment.

   a. Systems requiring testing via approved devices will be identified below.

   b. Required test devices will be listed in related sections.

   c. Provide unified testing results of similar systems. Describe testing procedure including all test equipment used.

   d. Provide original results from testing equipment (as applicable).

2. Failure to submit testing documentation conducted via approved devices will result in delayed final acceptance by the Design Consultant.

3. Contractors unable to provide required test equipment shall employ the services, at their own expense, of a certified subcontractor to assist in testing and documentation.

F. Audio System

1. Electronics

   a. Test all system audio electronic components for uniform frequency response from input to power amplifier output:

      1) Supply pink noise to a single system input which engages most of the system electronics. For example, connect pink noise to a microphone receptacle on the stage for a Performing Arts facility.

      2) With all signal processing bypassed (equalization band pass filters, crossovers, dynamics, etc.), independently route the signal through audio console, DSP, and any other system processing components to an amplifier output.
3) With speaker load disconnected, measure the signal response of the selected amplifier output (to obtain viable measurement results, ensure output level is set to match the ability of the measurement device to display accurate information. This can be accomplished via attenuation of signal or insertion of a speaker level to line level attenuator).

4) Verify the measured response is uniform and matches the reference input signal within ±1dB from 30 Hz to 18 kHz.

5) Required test equipment - Signal Generation:
   a) Terrasonde/Sencore Audio-Toolbox; or
   b) Japan Audio Society CD-1 test compact disc
   c) NTI Minirator MR-PRO

6) Required test equipment – Measurement Device:
   a) Rational Acoustics SMAART system v7 or later; or
   b) NTI Audio XL2 Analyzer; or
   c) Studio Six Digital Audio Tools RTA or FFT Module, with
      i) Studio Six Digital iAudioInterface 2

b. Repeat measurement for each amplifier output channel.

2. Loudspeaker Impedance
   a. Measure and record the impedance of all loudspeaker circuits at the output of each amplifier. During this process, also check each loudspeaker circuit for shorts to ground.

b. Required test equipment:
   a) Dayton Audio DATS; or
   b) NTI Minirator MR-PRO; or
   c) Sennheiser ZP-3; or
   d) Terrasonde/Sencore Audio Toolbox

2) Unacceptable measurement devices for loudspeaker impedance include the following:
   a) Digital Multimeter (DMM); or
   b) TOA ZM-104; or
3. Loudspeaker Band Pass/Amplifier Assignment Confirmation

a. For full range loudspeakers, apply full spectrum pink noise at sufficient level in order to:

   1) Verify subjectively that each loudspeaker is emitting full spectrum signal (both woofer and tweeter/horn are operating)
   2) Confirm each loudspeaker is connected to the proper amplifier chassis and output channel.
   3) Verify proper phase of each loudspeaker.

b. For loudspeakers with multiple band pass sections (bi-amp, tri-amp, etc.), apply appropriately band-limited pink noise at sufficient level to each device or band pass (i.e. high frequency section, mid frequency section, low frequency section):

   1) Verify subjectively that each loudspeaker is emitting appropriately band-passed spectrum signal.
   2) Confirm each band pass is connected to the proper amplifier chassis and output channel.
   3) Verify phase of each band pass
4) Required test equipment
   a) Galaxy Audio CPTS Cricket Polarity Tester; or
   b) NTI Audio MR-PRO generator with XL2 Analyzer; or
   c) Studio Six Digital Audio Tools Speaker Polarity Module; with
      i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
      ii) Studio Six Digital iPrecisionMic; or
      iii) Studio Six Digital iTestMic; or
   d) Studio Six Digital Speaker Pop; with
      i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
      ii) Studio Six Digital iPrecisionMic; or
      iii) Studio Six Digital iTestMic

4. Loudspeaker Rattle
   a. Verify each loudspeaker is connected to the respective power amplifier and test each loudspeaker throughout its usable frequency range using 1/3-octave bands of pink noise to ensure loudspeaker and related building systems do not rattle.
   b. Required 1/3-octave band pink noise sources and test equipment include:
      1) Terrasonde/Sencore Audio-Toolbox; or
      2) Japan Audio Society CD-1 test compact disc
      3) NTI Minirator MR-PRO

5. Loudspeakers Uniformity of Coverage

6. Loudspeakers Equalization
   a. Perform sound system equalization to optimize system performance for the intended uses.
   b. Every loudspeaker shall be equalized.
   c. Required test equipment:
1) Calibrated Type 1 or Type 2 microphones shall be used

2) Studio Six Digital Audio Tools for the classrooms, meeting rooms, conference rooms gymnasium, lobby; with
   a) Studio Six Digital iPrecisionMic; or
   b) Studio Six Digital iTestMic; or

3) SmaartLive (most current non-beta version) with SmaartLive approved:
   a) Appropriate laptop
   b) Microphone interface

4) EASRA (most current non-beta version) with EASRA approved:
   a) Appropriate laptop
   b) Microphone interface

7. Microphone/Line Level
   a. Verify that all microphone and line level cabling and connectors are installed with Pins 1, 2, and 3 wired properly and there are no shorts to ground. Ensure proper polarity.
   b. Verify that all microphone connectors, extension cables, and microphones are wired properly and in polarity.
   c. Required test equipment:
      1) Alphaton ACT-100 Remote Tester; or
      2) NTI Minirator MR-PRO with Cable Test Adapter
      3) A microphone is NOT an acceptable measurement device for cable tests.

8. Wireless Microphones
   a. Setup and configure each wireless microphone system using the software provided by the manufacturer of the wireless microphone system. The following tasks are required:
      1) Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform an RF spectrum sweep.
      2) Perform frequency coordination with Owner. Take into account existing wireless microphone system(s).
3) Calculate spare RF channels (based on 5% of the total wireless system channels).

4) Perform frequency assignment of all transmitters/receivers per the results of the frequency coordination and RF spectrum sweep.

5) Verify all receivers are set to maximum line level audio output.

6) Set all handheld wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.

7) Set all body pack wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.

8) Using subjective listening, adjust the body pack settings to match the audio level of the handheld transmitters.

9) Walk the entire performance coverage area using speech as the program material to verify signal performance. Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform a QOS test.

10) Document wireless microphone frequency assignments including coordinated spare channels.

9. Production Intercom System
   a. Verify that all intercom level cabling is installed with pins 1, 2, and 3 wired properly and there are no shorts to ground. Ensure intercom system power supply is disconnected for these tests.

   b. Required test equipment:
      1) Alphaton ACT-100 Remote Tester; or
      2) NTI Minirator MR-PRO with Cable Test Adapter

10. Assistive Listening System
   a. Setup and configure the assistive listening system. Verify proper input signal level.

   b. Walk the entire coverage area using speech as the program material to verify signal performance.

   c. Set all receivers to match the selected transmit channel(s).

G. Video System
1. Verify that all coax video cables pass a DC continuity cable test and contain no electrical shorts. Required test equipment includes:
   a. Fluke MicroScanner2; or
   b. Test-Um CX200; or
   c. Triplett 8-Way WireMaster Coax

2. Verify that all coax video cables pass a frequency sweep test for the bandwidth of intended use. Required test equipment includes:
   a. Tektronix RSA5000; or
   b. Rhode & Schwarz FPC1500; or
   c. Keysight Technology N9340B

3. Verify that all video cabling intended for use in SDI signals are tested to allow system conformance with SMPTE 424M. Required test equipment includes:
   a. Phabrix SxE; or
   a. Harris VideoTek HD-Star; or
   b. Quantum Data QD780C

4. Verify that all video systems utilizing DVI cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP as applicable, correct color space and bit depth, and correct frame rate. Required test equipment includes:
   a. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
   b. Murideo Fresco Field Test Suite; or
   c. Proton-LVDS Video Generator Analyzer; or
   d. Purelink HDG 2.0

5. Verify that all video systems utilizing HDMI or DisplayPort cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP, correct color space and bit depth, correct frame rate, HDR signal and metadata as applicable, and audio as applicable. Required test equipment includes:
   e. Hall Research PGA-VHD; or
      a. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
      b. Murideo Fresco Field Test Suite; or
   f. Quantum Data QD780C; or
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g. Purelink HDG 2.0; or

6. Setup and calibrate each visual display using current edition of Spears & Munsil High Definition Benchmark Disc. Perform calibration with environmental lighting set to level representative of the system while in use. Verify the each source and variety of resolutions. For projector/screen combinations, the screen drop shall be set to maximize observation from all seats and the image shall fill the available space on the screen.

7. Calibrate each video image using a repeatable, calibrated system. Provide documentation for each calibrated image. Results shall also become a part of the Operation/maintenance manuals. Required test equipment:

h. Datacolor Spyder5ELITE Display Calibration; or

a. SpectraCal CalMAN Ultimate software (most recent version) running on Contractor-provided laptop which exceeds the minimum requirements stipulated by SpectraCal.

1) Supported Meters: as recommended by SpectraCal

2) Supported Pattern Sources: as recommended by SpectraCal; or

i. X-Rite ColorMunki Display

H. Control System

1. Verify performance of the Control System including the operation of all control features.

I. Adjustment

1. Repair or replace any defects or malfunctions found prior to the commencement of final acceptance activities by the Design Consultant.

J. Testing Documentation Submittal

1. Document the results of all tests and compile into a complete Testing Documentation submittal with the following items:

a. Results of the tests detailed herein; and

b. Documentation of changes to the systems as a result of any project Change Order, ASI, field directive, Owner Representative direction or the Testing and Adjustment process.

c. Digital photographs of primary systems, sub-systems and components; and

d. Written notice to the Design Consultant that the system(s) are ready for final acceptance.

2. Include the approved Testing Documentation package in the Operation and Maintenance Data package.
3. Modify the Record Drawings to include any changes as a result of the adjustment process.

K. Contact the Design Consultant should problems or concerns arise during the testing activities.

L. Transmit the Testing Documentation submittal to the Design Consultant in a timely fashion to allow the Consultant appropriate time for review and comment prior to scheduling of final acceptance. The Consultant cannot visit the site or begin the acceptance phase until the submittal has been approved.

M. Should the Design Consultant be required to invest time performing some or all of the tests, the Contractor will compensate the Design Consultant for all associated costs.

3.8 FINAL ACCEPTANCE

A. After completion of the system installation and after the preliminary tests and adjustments are complete, the contractor in conjunction with the Design Consultant shall perform on-site acceptance of the technical system. This process will include, but not be limited to the following, as applicable:

1. Random verification of contractor tests;

2. System check-out;

3. Tailoring of the technical system's frequency response to the facility's acoustical environment (where required);

4. Observation of video system to verify proper image display;

5. Function and operability of the control system.

B. Provide the services of the designated supervisor and any other technicians who are familiar with the system, for approximately two eight-hour days. Additional time may be required due to Alternates accepted by the Owner’s Representative, or due to Addenda or Change Orders (if any) which modify the scope of work. The supervisor shall provide personal assistance during these activities. This time period does not include time for correcting wiring errors, equipment malfunctions, or problems related to the installation of the technical system. This work could occur at any time day, night, weekends, or holidays without additional claims for expense.

C. At the discretion of the Design Consultant, the Contractor shall participate in the control and adjustment of computer controlled systems including but not limited to the following systems: Main control (Crestron/AMX), DSP, wireless microphone, amplifier, active loudspeaker, etc.

D. At the completion of the final acceptance period, the Contractor shall compile all system configuration settings (files) with copies as required for inclusion in the O&M Manuals described later in these specifications.

E. In addition, provide the following: hand and power tools appropriate for the type of installation, ladders, lifts, and/or scaffolding as required to reach all high-mounted devices, spare wire and cable of the types used in the installation, selection of wiring fasteners used in the installation, complete set of the most recent reviewed shop drawings, complete set of all manufacturers’
original installation/operation/maintenance manuals, and specific test equipment used during the preliminary testing activities.

F. After the technical system is operational, the Contractor shall provide verbal instruction to designated Owner’s Representative as to proper methods of system operation. Video record the instruction class and provide the recording in a usable digital format to the Owner’s Representative.

G. Provide operational assistance for the first major use of the completed system as directed by the Owner’s Representative, including being present for: one prior rehearsal associated with the event (if applicable); a technical-check immediately prior to the event; and the event itself.

3.9 OPERATION AND MAINTENANCE DATA

A. At the completion of the project, compile thorough copies of the Operation and Maintenance (O&M) Data per Division 27 Section “General Communications Requirements”.

B. O&M data shall be assembled according to rooms or areas as it relates to the project site. The intent is to allow the Owner’s Representative to easily locate information relating to a specific system/room without having to spend an inordinate amount of time searching. Include complete information for each system/room – this may involve duplication of information.

C. Include ANSI E1.47-2017 (Entertainment Technology – Recommended Guidelines for Entertainment Rigging System Inspections) within the O&M data.

D. As applicable, save full digital version to the system computer.

END OF SECTION
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SECTION 274110 - TELECOMMUNICATIONS REQUIREMENTS FOR AUDIO VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a Telecommunications Structured Cabling System to support a complete and functioning Audio Video System. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, and transport to provide the following:

1. Shielded Category 6 Horizontal Cabling
2. Category 6 Faceplates & Shielded Connectors
3. Modular Category 6 Patch Panels
4. Shielded Category 6 Patch Cables
5. Category 6 Horizontal Cabling
6. Category 6 Faceplates & Connectors
7. Category 6 Patch Cables

B. All Category 6 components provided under this section shall comply with Warranty requirements as defined within this section and shall be installed and tested by a certified contractor of the warranty provider. Refer to the Quality Assurance and Warranty paragraphs of this specification for more information on this requirement.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

1. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section “General Communications Requirements”

2. Work under this section shall follow Division 27 Section “Common Work Results for Communications” for general pathway, firestopping, access panel, identification, and other requirements.

B. Refer to Division 27 “Audio Video Systems” and related sections and drawings for additional requirements and coordination items. Coordinate all work with Division 27 “Audio Video Systems” Contractor.

1.3 CODES, STANDARDS, AND GUIDELINES

A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections “General Communications Requirements” and “Audio Video Systems”, follow the most recent editions of the following:

1. NFPA 70 – National Electrical Code (NEC)
2. IEEE National Electrical Safety Code (NESC)
3. ANSI/TIA-568-C.O - Generic Telecommunications Cabling for Customer Premises
5. ANSI/TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards
6. ANSI TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces
7. ANSI TIA-606-B – Administration Standard for Commercial Telecommunications Infrastructure
8. BICSI - Telecommunications Distribution Methods Manual

1.4 DEFINITIONS

A. Advanced System Warranty – a minimum 20-year warranty covering material and performance of the telecommunications structured cabling system offered by a reputable manufacturer. Refer to the Quality Assurance section of this specification for more information.

B. Cable Manufacturer – Manufacturer that furnishes the horizontal and backbone cables of the structured cable system.

C. Connectivity Manufacturer – Manufacturer that furnishes the connectivity components of the structured cable system including but not limited to: patch panels, work area outlets, and patch cables)

D. Contractor – in regards to this section only, the contractor responsible for providing a complete Telecommunications Structured Cabling System for Audio Video Systems. This contractor shall be a certified contractor of the manufacturer providing the Advanced System Warranty. Where the Contractor of Division 27 Section “Audio Video Systems” does not meet this requirement, they shall engage the services of a subcontractor who meets the requirements of this section.

E. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.

F. Horizontal Cabling
1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located at the equipment rack. This cabling and its connecting hardware are called “permanent link,” a term that is used in the testing protocols.
a. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector

b. Bridged taps and splices shall not be installed in the horizontal cabling

2. The maximum allowable horizontal cable length for Category copper cable is 295 feet (90 meters), which includes total cable length (including vertical routing and slack).

G. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed category copper cable terminated onto a patch panel, direct attach connector, or outlet.

H. Technical System Ground – the isolated ground system provided specifically for the Technical (AV) System, as specified in Division 27 section “Audio Video Systems”.

I. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.5 QUALITY ASSURANCE

A. Contractor Qualifications

1. Contractor shall be certified and capable of offering an Advanced System Warranty from one of the manufacturers listed herein. (Refer to Warranty and Coordination sections for additional requirements.)

B. Personnel Qualifications

1. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher or equivalent training from the Advanced System Warranty manufacturer.

   a. Submit certificates with pre-construction submittals.

2. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Section shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training.

3. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.

4. Alternate qualifications may be considered if requested alternates are provided in accordance with the Substitution instructions in Division 27 Section “General Communications Requirements”.
1.6 SUBMITTALS

A. Follow the requirements for submittals in Division 27 Sections “General Communications Requirements” and “Audio Video Systems”.

B. Pre-construction - Follow exact Division 27 Section “Audio Video System” submittal requirements, with additional requirements as noted:

1. Manufacturers’ Cut-sheets – Additional requirements as follows:
   a. Product data on cabling shall contain the following:
      1) Manufacturers name and logo
      2) Cable outside diameter
      3) Number of conductors/strands in each cable
      4) Gauge or strand thickness
      5) Minimum transmission performance rating
      6) Cable jacket material and rating
      7) Maximum pulling tension
      8) Jacket/Sheath color
      9) Minimum bend radius
         a) During installation and post installation, if different
   b. Product data on faceplates, modules, connectors, patch panels, and enclosures shall contain the following:
      1) Manufacturers name and logo
      2) Material type
      3) Performance rating
      4) Physical Dimensions
      5) Color

2. Shop Drawings
   a. Scaled layout drawings showing the routing (and support method) of all cabling, and the locations where patch panels, Telecommunications outlets, cable types, cable jacket listing information, and firestop locations (with quantity and NRTL system number identified) are to be installed.
1) Each individual outlet on the drawings shall have proposed outlet identification indicated.

b. Scaled enlarged plan and rack elevation drawings showing the locations of patch panels and Rack-Mount Enclosures.

c. Unless otherwise required by these specifications, it is permissible to show Work in this section on Division 27 “Audio Video Systems” shop drawings.

3. Warranty Information

a. Subject to Warranty paragraph, provide sample warranty certificate for the Warranty, indicating manufacturer and their terms/conditions

b. Proof that Contractor is certified with the manufacturer

C. Project Completion - Follow exact Division 27 Section “Audio Video Systems” submittal requirements, with additional requirements as noted:

1. As part of Division 27 Audio Video Systems – Operation & Maintenance Data submittal, also include the following documentation:

a. Warranty Certificates (if applicable)

b. Cable routing and Outlet locations identified on Audio Video Systems Final Record Drawings, in searchable Acrobat PDF format (so that Work Area Outlet identifiers can be searched for)

c. Test Results, in PDF, spreadsheet and original test equipment format

d. Delivery confirmation of spare Patch Cables delivered to Owner

1) Refer to Division 27 “Audio Video Systems” and herein for quantities

1.7 COORDINATION

A. Review pathways and other Work, as installed per Division 27 section “Common Work Results for Communications”, prior to performing any Work under this section for conformance to all referenced codes, standards, and guidelines.

1. While Division 27 section “Common Work Results for Communications” is being installed, the Project Manager of this section and the Project Manager of Division 27 “Audio Video Systems” contractor shall make weekly inspections and report any issues to the Prime Contractor for correction prior to installation of any cabling.

a. Example – Conduit for Category 6 data outlets shall not contain more than two 90 degree bends between pull points.

B. For projects with other Division 27 telecommunications work, coordinate with Division 27 Telecommunications Contractor(s) prior to bid – similar products shall be by the same manufacturer.
1. This includes:
   a. Horizontal and backbone cabling
   b. Copper connectivity

2. The Advanced System Warranty from this section shall be from the same manufacturer as Division 27 “Structured Cabling System”.

C. Coordinate with Division 27 “Audio Video Systems” contractor for all Work in AV equipment racks.

1.8 WARRANTY

A. The Telecommunications Structured Cabling System (as specified in this Section) requires an Advanced System Warranty as defined herein. Contractor shall comply with Quality Assurance requirements with respect to Advanced System Warranty certifications and shall be in good standing with the manufacturer.

1. All components, including but not limited to, connectors, patch panels, cabling and all other components considered to be a part of what is commonly referred to as an end-to-end solution for all backbone and horizontal cabling systems, shall be warranted for a minimum period of 20 years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/EIA/IEC/ISO standards for each cable system specified. This warranty shall include all current and future applications and transmission requirements for the installed cable type/system.

2. Warranty shall be guaranteed by a single reputable manufacturer such as:
   a. Belden
   b. Hubbell
   c. Leviton
   d. Mohawk Cabling
   e. Ortronics
   f. Panduit
   g. Superior Essex
   h. Systimax
   i. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

3. This warranty shall extend to Category Neutrik connectors specified in Division 27 “Audio Video Systems”. Coordinate with proposed manufacturer of Advanced System Warranty prior to bid to ensure they will extend coverage to this product for this project.
a. Include letter in Pre-Construction Product Submittals from manufacturer certifying this requirement will be met.

4. Where warranty is by connectivity manufacturer, all connectivity shall be by said manufacturer and cabling manufacturer shall be compatible for use with the selected connectivity.

5. Where another Division 27 specifies a similar warranty and manufacturer for a telecommunications structured cabling system, provide products and a warranty from the same manufacturer.

6. Advanced System Warranty shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

7. Perform the remedial work promptly, upon written notice from the Owner.

8. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL REQUIREMENTS

A. All cabling shall be from a single cable manufacturer.

B. All connectivity shall be from a single connectivity manufacturer. This manufacturer shall be an approved partner of the cable manufacturer listed in 2.1.A.

1. Exception: Certain broadcast and faceplate connections/components as specified.

C. All cabling and connectivity specified in this section shall be covered by a single Advanced System Warranty.

D. The following manufacturers are conditionally approved to provide the Advanced System Warranty (subject to Coordination requirements in Part 1 of this Section):

1. Belden
2. Hubbell Premise Wiring
3. Leviton
4. Ortronics Network Infrastructure
5. Panduit Network Solutions
6. Superior Essex
2.2 SHIELDED CATEGORY 6 HORIZONTAL CABLING

A. Horizontal cables for dry environments

1. Requirements
   a. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
   b. Aluminum Foil Tape Shield (F/UTP)
   c. Four pairs of 23 AWG copper conductors with drain wire
   d. Cable jacket color(s) shall be
      1) As coordinated with Owner’s Representative
   e. Cable jacket marking: Shall be legible and shall contain the following information:
      1) Manufacturer’s name
      2) Copper Conductor Gauge
      3) Pair Count
      4) UL and CSA listing
      5) Manufacturer’s trade mark
      6) Category rating
      7) Sequential distance markings, in one foot increments
   f. Individually insulated conductors under a common sheath
   g. Where all cables are to be installed in conduit from outlet box to AV Equipment Rack, cable shall be riser (CMR or MPR) rated. Where any portion of any cable is routed in an air plenum space, cable shall be plenum (CMP) rated.

2. Manufacturer shall be:
   a. From the following list, subject to Coordination and Warranty requirements:
      1) Superior Essex CAT 6+ ScTP
      2) Belden DataTwist 2400
      3) Berk-Tek LANMARK-6 FTP
      4) Hitachi Shielded Category 6 Cable
      5) Hubbell Speedchannel FTP Cable, Category 6
6) Mohawk Category 6 F/UTP
7) Panduit TX6000 Shielded Copper Cable

B. Horizontal cables for wet environments in ducts/conduits

1. Requirements
   a. To be used for pathways in or below slab-on-grade, or where any part of pathway is external to the building or in a Wet or Damp Location (as defined by the NEC).
      1) Pathway shall enter the building (where it stubs up out of the slab) in the AV Equipment Room, or within 50’ of AV Equipment Room. Coordinate this requirement with Division 27 section “Common Work Results for Communications”.
   b. Suitable to be in contact with standing water.
   c. Cable construction shall be consistent with manufacturer’s specifications to comply with Warranty requirements.
   d. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
   e. Four pairs of 23 AWG solid copper conductors
   f. Aluminum Tape Shield (F/UTP)
   g. Cable shall be wet-rated / OSP-rated.
      1) And shall transition to a listed cable (plenum or riser rated as appropriate) where it enters the building.
      2) This transition is not needed if the conduit stubs up directly into the Communications Room.
   h. Cable jacket marking: Shall be legible and shall contain the following information:
      1) Manufacturer’s name
      2) Copper Conductor Gauge
      3) Pair Count
      4) UL and CSA listing
      5) Manufacturer’s trade mark
      6) Category rating
      7) Sequential distance markings, in one foot increments
2. Manufacturer shall be:
   a. From the following list, subject to Coordination and Warranty requirements:
      1) Superior Essex OSP Broadband Category 6
      2) Or Approved Equivalent

2.3 CATEGORY 6 HORIZONTAL CABLEING

A. Horizontal cables for dry environments

1. Requirements
   a. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
   b. Four pairs of 23 AWG copper conductors
   c. Cable jacket color(s) shall be
      1) As coordinated with Owner’s Representative
   d. Cable jacket marking: Shall be legible and shall contain the following information:
      1) Manufacturer’s name
      2) Copper Conductor Gauge
      3) Pair Count
      4) UL and CSA listing
      5) Manufacturer’s trade mark
      6) Category rating
      7) Sequential distance markings, in one foot increments
   e. Individually insulated conductors under a common sheath
   f. Where all cables are to be installed in conduit from outlet box to AV Equipment Rack, cable shall be riser (CMR or MPR) rated. Where any portion of any cable is routed in an air plenum space, cable shall be plenum (CMP) rated.

2. Manufacturer shall be:
   a. From the following list, subject to Coordination and Warranty requirements:
      1) Superior Essex CAT 6+
      2) Belden DataTwist 2400
3) Berk-Tek LANMARK-6
4) Hitachi Category 6 Cable
5) Hubbell Speedchannel Cable, Category 6
6) Mohawk Category 6
7) Panduit TX6000 Copper Cable

B. Horizontal cables for wet environments in ducts/conduits

1. Requirements
   a. To be used for pathways in or below slab-on-grade, or where any part of pathway is external to the building or in a Wet or Damp Location (as defined by the NEC).
      1) Pathway shall enter the building (where it stubs up out of the slab) in the AV Equipment Room, or within 50’ of AV Equipment Room. Coordinate this requirement with Division 27 section “Common Work Results for Communications”.
   b. Suitable to be in contact with standing water.
   c. Cable construction shall be consistent with manufacturer’s specifications to comply with Warranty requirements.
   d. Minimum performance specifications: Cable shall meet requirements for Category 6 of TIA-568-C.
   e. Four pairs of 23 AWG solid copper conductors
   f. Cable shall be wet-rated / OSP-rated.
      1) And shall transition to a listed cable (plenum or riser rated as appropriate) where it enters the building.
      2) This transition is not needed if the conduit stubs up directly into the Communications Room.
   g. Cable jacket marking: Shall be legible and shall contain the following information:
      1) Manufacturer’s name
      2) Copper Conductor Gauge
      3) Pair Count
      4) UL and CSA listing
      5) Manufacturer’s trade mark
6) Category rating

7) Sequential distance markings, in one foot increments

2. Manufacturer shall be:
   a. From the following list, subject to Coordination and Warranty requirements:
      1) Superior Essex OSP Broadband Category 6
      2) Or Approved Equivalent

2.4 SHIELDED CATEGORY 6 CONNECTIVITY

A. Connectors / Jacks
   1. General Requirements
      a. Outlets shall meet requirements for Category 6 of TIA-568-C.
      b. All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
      c. Outlet hardware shall be UL listed.
   2. Female RJ-45 Shielded Category 6 Jack
      a. For installation with shielded Category 6 cable into:
         1) Dedicated AV LAN faceplates (where no other type of AV connectors are needed)
         2) Rack-mounted Patch Panels
      b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
         1) Ortronics TracJack
         2) Belden Key Connect
         3) Hubbell UDX
         4) Leviton QuickPort
         5) Panduit Mini-Com
   3. Male RJ-45 Shielded Category 6 connector
      a. For installation onto far end of shielded Category 6 cable at the following locations only:
1) In-wall Touch Panels
2) Crestron DM Transmitters & Receivers
3) Other locations where it is not practical to terminate cabling onto a faceplate or into a small Surface Mount (Biscuit) Box.

b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
   1) Ortronics TracJack
   2) Belden Key Connect
   3) Hubbell UDX
   4) Leviton QuickPort
   5) Panduit Mini-Com

4. EtherCON Female RJ-45 Shielded Category 6 connector
   a. For installation in custom AV faceplates where other types of AV connectors are needed
   b. Manufacturer shall be:
      1) Refer to Division 27 Section “Audio Video Systems”

B. Faceplates – where only AV LAN connectors are needed, such as behind a TV

1. Requirements
   a. Stainless Steel with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
   b. Color shall be stainless steel
   c. Single gang or double gang, as noted on the drawings or required to provide a complete and functioning system

2. Product shall be as follows, subject to Coordination and Warranty requirements:
   a. From the following list:
      1) Belden Key Connect
      2) Hubbell UDX
      3) Leviton QuickPort
      4) Ortronics TracJack
5) Panduit Mini-Com

6) Or Approved Equivalent

b. Decora-style inserts

1) Provide as necessary per drawings/details

2) Color shall match faceplate or electrical, or as directed by the architect

c. Blank inserts

1) Provide blank modules to fill any unused openings in faceplates

2) Color shall match other jack colors

C. Surface mount ("Biscuit") box – for installation as needed in junction/back box, projector lift, etc. where installation of a faceplate is not practical.

1. Requirements

a. Thermoplastic surface-mount style box with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.

2. Product shall be as follows, subject to Coordination and Warranty requirements:

a. From the following list:

1) Belden KeyConnect Side-Entry Box

2) Hubbell iStation Surface Mount Box

3) Leviton QuickPort Surface-Mount Box

4) Ortronics TracJack Surface Mount Box

5) Panduit Mini-Com Surface Mount Box

D. Modular Category 6 Patch Panels

1. Requirements

a. Be of a modular metal design with snap in frames for individual jacks/connectors.

b. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard 19" wide racks.

c. Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
d. Patch panels shall be provided complete with all mounting hardware, modular jacks, retainers, wire guides, designation strips, etc.

e. Provide enough patch panels for the number of cables terminated on the patch panel, plus 10 percent spare. Provide modular jacks to fill each panel completely. Do not leave any blank openings.

2. Product shall be as follows, subject to Coordination and Warranty requirements:

a. From the following list:
   1) Belden KeyConnect Modular Patch Panels
   2) Hubbell UDX Panels
   3) Leviton QuickPort Patch Panels
   4) Ortronics OR-PHDPJU24
   5) Panduit Mini-Com Modular Patch Panels

2.5 CATEGORY 6 CONNECTIVITY

A. Connectors / Jacks

1. General Requirements

   a. Outlets shall meet requirements for Category 6 of TIA-568-C.

   b. All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.

   c. Outlet hardware shall be UL listed.

2. Female RJ-45 Category 6 Jack

   a. For installation with Category 6 cable into:

      1) Dedicated AV LAN faceplates (where no other type of AV connectors are needed)

      2) Rack-mounted Patch Panels

   b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:

      1) Ortronics TracJack

      2) Belden Key Connect

      3) Hubbell UDX
4) Leviton QuickPort

5) Panduit Mini-Com

3. Male RJ-45 Category 6 connector
   a. For installation onto far end of Category 6 cable at the following locations only:
      1) In-wall Touch Panels
      2) Crestron DM Transmitters & Receivers
      3) Other locations where it is not practical to terminate cabling onto a faceplate or into a small Surface Mount (Biscuit) Box.
   b. Manufacturer shall be from the following list, subject to Coordination and Warranty requirements:
      1) Ortronics TracJack
      2) Belden Key Connect
      3) Hubbell UDX
      4) Leviton QuickPort
      5) Panduit Mini-Com

4. EtherCON Female RJ-45 Category 6 connector
   a. For installation in custom AV faceplates where other types of AV connectors are needed
   b. Manufacturer shall be:
      1) Refer to Division 27 Section “Audio Video Systems”

B. Faceplates – where only AV LAN connectors are needed, such as behind a TV

1. Requirements
   a. Stainless Steel with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
   b. Color shall be stainless steel
   c. Single gang or double gang, as noted on the drawings or required to provide a complete and functioning system

2. Product shall be as follows, subject to Coordination and Warranty requirements:
   a. From the following list:
1) Belden Key Connect
2) Hubbell UDX
3) Leviton QuickPort
4) Ortronics TracJack
5) Panduit Mini-Com
6) Or Approved Equivalent

b. Decora-style inserts
   1) Provide as necessary per drawings/details
   2) Color shall match faceplate or electrical, or as directed by the architect

c. Blank inserts
   1) Provide blank modules to fill any unused openings in faceplates
   2) Color shall match other jack colors

C. Surface mount ("Biscuit") box – for installation as needed in junction/back box, projector lift, etc. where installation of a faceplate is not practical.

   1. Requirements
      a. Thermoplastic surface-mount style box with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.

   2. Product shall be as follows, subject to Coordination and Warranty requirements:
      a. From the following list:
         1) Belden KeyConnect Side-Entry Box
         2) Hubbell iStation Surface Mount Box
         3) Leviton QuickPort Surface-Mount Box
         4) Ortronics TracJack Surface Mount Box
         5) Panduit Mini-Com Surface Mount Box

D. Modular Category 6 Patch Panels

   1. Requirements
      a. Be of a modular metal design with snap in frames for individual jacks/connectors.
b. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard 19” wide racks.

c. Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.

d. Patch panels shall be provided complete with all mounting hardware, modular jacks, retainers, wire guides, designation strips, etc.

e. Provide enough patch panels for the number of cables terminated on the patch panel, plus 10 percent spare. Provide modular jacks to fill each panel completely. Do not leave any blank openings.

2. Product shall be as follows, subject to Coordination and Warranty requirements:

   a. From the following list:

      1) Belden KeyConnect Modular Patch Panels
      2) Hubbell UDX Panels
      3) Leviton QuickPort Patch Panels
      4) Ortronics OR-PHDPJU24
      5) Panduit Mini-Com Modular Patch Panels

2.6 SHIELDED CATEGORY 6 PATCH CABLES/CORDS

   A. Requirements

      1. Factory-terminated and tested
      2. Shall meet requirements for Category 6 of TIA-568-C
      3. Shielded
      4. Provide quantities and lengths as necessary for a complete Audio Video System; coordinate requirements with Division 27 “Audio Video Systems” contractor.
      5. In the AV Equipment Room/Rack, Color shall correspond to the following VLANs:

         a. Crestron/AMX/Extron AV distribution/control – black
         b. IP / Control connections – purple
         c. Audio Networks – blue
         d. HDBaseT distribution – grey
      6. For patch cables/cords at the work area outlet, color shall be black.
B. Product shall be from the same manufacturer as the patch panel manufacturer:

1. From the following list:
   a. Belden
   b. Hubbell
   c. Leviton
   d. Ortronics
   e. Panduit

2.7 CATEGORY 6 PATCH CABLES/CORDS

A. Requirements

1. Factory-terminated and tested
2. Shall meet requirements for Category 6 of TIA-568-C
3. Provide quantities and lengths as necessary for a complete Audio Video System; coordinate requirements with Division 27 “Audio Video Systems” contractor.
4. In the AV Equipment Room/Rack, Color shall correspond to the following VLANs:
   a. Crestron/AMX/Extron AV distribution/control – black
   b. IP / Control connections – purple
   c. Audio Networks – blue
   d. HDBaseT distribution – grey
5. For all far-end connections, color shall be black.

B. Product shall be from the same manufacturer as the patch panel manufacturer:

1. From the following list:
   a. Belden
   b. Hubbell
   c. Leviton
   d. Ortronics
   e. Panduit
2.8 COPPER TESTING EQUIPMENT

A. The following Test Equipment is Conditionally Approved for Contractor use.
   
a. Category 6 Cable Tester

2. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.
   
a. Category 6 Cable Tester

   1) Fluke www.flukenetworks.com
   2) Greenlee www.greenlee.com
   3) Ideal www.idealindustries.com
   4) JDSU www.jdsu.com

3. Requirements

   a. The field tester shall be a level III or greater.
   
b. The field tester shall meet the requirements of TIA-568.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

A. General

1. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
   
a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
   
b. No horizontal Category 6 cables shall exceed the allowed maximum distance of 295 feet (90 meters) by TIA-568-C.

2. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system.
   
a. All horizontal cables shall be suitable for installation in their environment, either plenum (CMP, MPP, OFNP, or OFCP) or riser (CMR, MPR, OFNR, or OFCR) rated, unless otherwise noted.
   
b. Horizontal cables installed in Wet Locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
3. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
   
   a. Except when supported by ladder racking within each AV Equipment Room/Rack, UON.

4. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.

5. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

6. Comply with all referenced standards and guidelines.

7. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.

8. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the device (if not in conduit) and one at the equipment room/enclosure. Each slack/service loop shall be:
   
   a. A minimum of 8 feet (2.44 meter) in length, UNO
   
   b. Configured in a loosely formed figure eight configuration (i.e. not coiled)

9. Use of any cable pulling lubricants is prohibited.
   
   a. Where lubricant is deemed necessary by the contractor to facilitate installation of cable in conduit, submit RFI with explanation, effected conduit run, proposed lubricant type, letter from cable manufacturer indicating proposed lubricant will not damage or degrade cable, and a letter from the manufacturer providing the Advanced System Warranty (if applicable) that the use of this lubricant will not exclude that cable run from the required warranty.

B. Outside plant cable installation: for cables placed in Wet or Damp Locations (as defined by the NEC) or as required by these construction documents. (i.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)

   1. Coordinate installation of conduit serving Wet Locations so conduit stubs up directly into Equipment Room, if practical.
   
   2. If conduit serving Wet Locations cannot be installed so conduit stubs up directly into Equipment Room, utilize IMC or RMC conduit to within 50 feet (15.24 meter) of the cable termination point.
3. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.

4. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.
   a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.

5. All cables which extend beyond the envelope/footprint of the building or serving outlets/devices on external walls or roofs shall be installed with entrance protectors in accordance with this section.

### 3.2 CONNECTOR INSTALLATION

A. Furnish and install all cable connectors as shown on the Drawings.

B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.

C. The provision and termination of connectors from each cable shall be done as follows:
   1. Where connector types are identified on the applicable drawings or in the specifications, furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer’s printed instructions.
   2. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

D. Copper Connector Installation
   1. Terminate all four pairs of each cable on one outlet jack. Ensure shield/foil and drain wire are properly installed according to manufacturer’s instructions.
   2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
   3. The provision and termination of connectors for each cable shall be done as follows:
      a. Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer’s printed instructions.
      b. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

### 3.3 FACEPLATE INSTALLATION

A. Furnish and install all faceplates in locations as shown on the Drawings.
1. Where co-located on AV faceplates, coordinate installation with Division 27 “Audio Video Systems” contractor.

3.4 CABLE IDENTIFICATION

A. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings. If the drawings do not address labeling scheme, submit RFI through appropriate channels requesting labeling scheme.

1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.

B. Cables shall be labeled within 6" at each end.

C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:

1. Brady, IDXPERT
2. Hellermann Tyton, Spirit 2100
3. Panduit LS9
4. Or Approved Equivalent

3.5 ENTRANCE PROTECTION INSTALLATION

A. Install grounding wire as straight as possible from protector to the Technical System Ground.

B. Grounding and bonding

1. Bond all metallic shields and armored jacketing material for all incoming cables as close as practicable to the entry into the building.

2. Bonding conductors shall be connected to the Technical System Ground and in accordance with NEC chapter 8.

3.6 GENERAL CABLE TESTING

A. Pre-installation testing:

1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.

2. Mark reels or boxes as tested/inspected.

3. Do not install any cable with less than the manufacturer’s guaranteed number of serviceable conductors.

4. The field-test instruments shall be within the calibration period recommended by the manufacturer and shall contain the most recent software and firmware provided by the manufacturer prior to testing.
B. Post-installation testing:

1. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.

2. Provide testing in accordance with manufacturer’s requirements for a fully warrantied cabling system(s) as required by these Contract Documents.

3. All outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.

4. Invite the Owner and Design Consultant to witness, review, or both witness and review field-testing.
   a. The Owner and the Design Consultant shall be notified of the testing start date (2) weeks before testing commences.

5. Remove all defective cables from pathway systems.

6. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found. Do not abandon cables in place.

C. All test results and corrective procedures are to be documented and submitted to the Design Consultant as part of the Project Completion submittal(s) and the Contractor’s Testing and Adjustment requirements of Division 27 Section “Audio Video Systems”.

1. Submit updated Record Drawings along with completed Test Results. Record Drawings shall have final outlet labels that correspond to the identification used in the Test Results.

2. Format of test results shall be:
   a. Electronic Database Test Results - Abbreviated results, in PDF and Excel/CVS file formats, shown in numerical / alphabetical order in a spreadsheet which depicts the following:
      1) Project Name
      2) Date of Preparation
      3) ID of Work Area Outlet / connector being tested
      4) Date of test
      5) Contractor’s Name
      6) Media Type
      7) Make, Model and Serial Number of test equipment used
      8) Date of Last Calibration
9) Names of Test Crew

10) Serving Communications Room Number
   a) All tests shall be submitted in numerical / alphabetical order by Communications / Equipment Room.

11) Category of cable being tested

12) Abbreviated Test Results depicting Pass, Fail status
   b) Full Test Results – test results saved within the field-test instrument and then transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of the test records, shown in numerical / alphabetical order in the file format of the tester (example: .mdb file, and unaltered.

1) Project Name

2) Date of Preparation

3) ID of Work Area Outlet / connector being tested

4) Date of test

5) Contractor’s Name

6) Media Type

7) Make, Model and Serial Number of test equipment used

8) Date of Last Calibration

9) Names of Test Crew

10) Serving Telecommunications Room Number
    a) All tests shall be listed in numerical / alphabetical order by Communications / Equipment Room.

11) Category of cable being tested

12) Full Test Result data

D. Final Acceptance Review

1. Final Acceptance Review will take place in conjunction with the Design Consultant Commissioning as specified in Division 27 Section “Audio Video Systems”. Final Acceptance Review cannot take place until Design Consultant receives Test Results and Record Drawings.
2. Provide a minimum of two suitably qualified cabling/testing technicians to be present on-site for a period of two hours during the scheduled Final Acceptance Review. Be prepared to conduct on-the-spot cable tests.

3. During the Final Acceptance Review, the Owner or the Design Consultant may select a random sample of up to 10% of the installed links for the Contractor to retest. The measured results obtained from the random sample shall be compared to the Test Results provided by the Contractor.

4. If 10% or more of the randomly tested cables differ in terms of the pass/fail determination or in cable length, the Owner and Design Consultant reserve the right to require a re-testing of 100% of the cable plant by the Contractor at the Contractor's expense.

5. Successful equipment performance tests do no relieve the Contractor from the specified testing, repair, and documentation requirements.

3.7 COPPER CABLE TESTING

A. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.

B. Four-Pair Cables:

1. After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:

   a. Category 6
      1) Wire map
      2) Length
      3) Insertion loss
      4) Near-end crosstalk (NEXT) loss.
      5) Power sum near-end crosstalk (PSNEXT)
      6) Equal-level far-end crosstalk (ELFEXT)
      7) Power sum equal-level far-end crosstalk (PSELFEXT)
      8) Return loss
      9) Propagation delay
      10) Delay skew

C. Two-Pair Cables:

1. After terminating both ends of all 2-pair cables, but before any cross-connects are installed, test these cables for the following:
a. Category 3
   1) Wire map
   2) Length
   3) Insertion loss
   4) Return loss
   5) Propagation delay

D. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis above. Any Permanent Link or Modified Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation.

3.8 ACCEPTANCE

A. All Work in this section is subject to the Project Completion and Schedule requirements of Division 27 section “Audio Video Systems”.

B. After Final Acceptance Review:
   1. Complete all Punch List items.
   2. Retest effected cables.
   3. Among other requirements, submit updated and complete Record Drawings/Test Results and the Advanced System Warranty certificate as part of Division 27 Audio Video Systems – Operation and Maintenance Data Submittal.

END OF SECTION
SECTION 274116 - AUDIO VIDEO SYSTEMS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes the equipment for the audio-video (AV) system (hereafter referred to as the “Technical System”).

1.2 RELATED DOCUMENTS

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

1. Division 27 Section “Audio Video Systems”.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Division 27 Section “Audio Video Systems” for general product requirements.

B. All components of the technical system equipment shall be provided and installed by a qualified contractor as outlined in Division 27 Section “Audio Video Systems”.

C. All electronic audio devices shall have electronic or transformer balanced inputs and outputs except for specific program source equipment and mixing console inputs and/or outputs. If an electronic device specified or furnished has an unbalanced input and/or output, make provisions to balance said input/output (i.e., active signal balancing device as approved) unless other arrangements have been agreed upon with the Design Consultant.

2.2 COMMON EQUIPMENT

A. Refer to Division 27 Section “Audio Video Systems” for common equipment and components.

2.3 MICROPHONES - INSTALLED

A. Microphone – Installed: installed, miniature shotgun, with XLR gooseneck adaptor (mount to Interview Ceiling:

1. Sennheiser ME 36 with MZH 3015 gooseneck; or

2. Approved equal.

2.4 PROGRAM SOURCE EQUIPMENT

A. Some of the program source equipment specified is consumer-grade equipment. Upon award of a contract, endeavor to procure these items as soon as possible to avoid delays caused by searching for discontinued product(s).
B. Rack-mount kit for equipment that requires rack mounting but is not provided with rack mount ears or optional rack mount kit:

1. Lowell RMK series; or
2. Middle Atlantic Products RSH series; or
3. Approved equal.

C. For each portable item of program source equipment, furnish one set of input/output cables (6-foot minimum length) and adapters (as required) to allow for connection to technical system inputs/outputs.

D. MP3 Input w/ Bluetooth – 2 Decora - Stereo: dual gang Decora style wallplate with 1/8” and dual RCA inputs, Bluetooth connectivity, Dante output, active:

1. Atterotech unD6IO-BT; or
2. Approved equal.

E. AV Receiver: Dolby Digital EX, DTS, ES, 5.1 surround sound amplifier:

1. Denon HEOS AVR; or
2. Approved equal.

2.5 AUDIO TRANSFORMERS - INSTALLED

A. Transformer – Summing, passive, dual unbalanced line level inputs on RCA connectors passively summed and then transformer balanced to one balanced mono line level output on a Phoenix connector or screw terminal, in a self-contained enclosure:

1. Extron ASA 141 (male RCAs on 24” cables); or
2. Radio Design Labs TX-J2 (female RCAs in a self-contained enclosure); or
3. Approved equal.

2.6 AUDIO DISTRIBUTION AMPLIFIERS

A. Distribution Amplifier – Press, self-powered press distribution box, minimum of four balanced mic/line-level input, minimum of twenty-four balanced transformer-isolated outputs, rack mounted:

1. AudioPressBox APB-400 R with APB-024 R-EX; or
2. Approved equal.

2.7 DIGITAL SIGNAL PROCESSING (DSP)

A. The AC power cord of the DSP shall be connected to a rack-mount uninterruptible power supply (UPS). Refer to the AC Power section for specific models. The UPS shall be connected to an unswitched (unsequenced) AC power circuit.
B. The Contractor shall create all schematics for the DSP and submit as a shop drawing. Refer to Submittals section for additional information.

C. Provide one computer with mouse and system features as recommended and approved by the manufacturer of the DSP system for use during final acceptance.
   1. If a computer is provided or designated for use as a system operation and configuration device, DSP software shall be loaded and the computer shall be operational during system final acceptance.
   2. If a permanent computer is not configured for technical system usage, furnish a wireless 802.11ac router and laptop computer configured to allow for wireless control of the DSP during system final acceptance. This equipment shall remain on site until final acceptance activities have been completed. Retain ownership of the router and laptop computer.

D. Password protection shall be included. One password shall be provided to allow operator access to select functions. Another password shall be provided for technical staff to access all aspects of the software.

E. Furnish all components for a fully functioning digital signal processing system.

F. DSP system basis of design is shown on the signal flows. Unterminated I/O or additional I/O cards shall be provided as shown on the signal flows for future use or additional requirements.

G. Substitutes to the basis of design will be considered if all features and functionality of the system requirements are met. I/O requirements shall meet or exceed the quantity of the basis of design. Processing requirements shall meet or exceed the basis of design to ensure proper operation of the system. The following manufacturers are pre-approved substitutes to the basis of design shown on the signal flows:
   1. BSS Soundweb London with:
      a. The most recent Audio Architect software.

2.8 POWER AMPLIFIERS

A. Power amplifiers in this section shall be by one manufacturer and operated in multi-channel mode to provide a minimum of two amplifier channels within one chassis unless noted otherwise.

B. All power amplifier inputs shall be either balanced analog inputs or digital network.

C. All front panel controls and AC power switches shall be either:
   1. concealed via a perforated metal security cover,
   2. concealed via manufacturer-supplied security cover,
   3. electronically disabled.

   The security cover shall not block air-flow for amplifier internal cooling.
D. All power amplifiers shall have standby/sleep mode functionality. This functionality shall be implemented on a system wide scale to provide a fully controlled power sequencing system. Preferred solution is network based; if amplifier does not have necessary features via network control, contact closure solution shall be utilized. Contact closure solution shall utilize a control system for triggering power on/off cycle.

1. Upon system shutdown, power amplifiers shall enter standby/sleep mode per manufacturer’s functionality.

E. Power amplifiers are listed by series, with the basis of design model shown on the signal flows. Deviation from the basis of design to an approved substitute shall be allowed as follows:

1. Power rating for high impedance (70V) operation shall meet or exceed the basis of design load requirement on the channel. Load shall be calculated based on total power (addition of all loudspeaker tap values) as indicated on the signal flows.

2. Power rating for low impedance operation shall meet or exceed the basis of design load requirement on the channel. Load shall be as indicated on the signal flows.

3. Channel count per chassis shall produce the most efficient solution of maximum channels vs appropriate power rating.

4. Proposed substitute should take into account:
   a. alterations of audio network requirements, as applicable. Alterations may include the need for additional network infrastructure, including network switches.
   b. alterations of audio system requirements, as applicable. Alterations may include the need for additional digital signal processing infrastructure.
   c. standby/sleep mode functionality. Alterations may include the need for additional network infrastructure or control system infrastructure.
   d. all other parameters, including but not limited to rack requirements and environmental considerations (AC power, thermal dissipation, weight, etc.).

F. Power Amplifier – Type (***)x/(*N(A)(B)(C)(D)(E)(Q): power amplifier, high (70V) or low impedance operation switchable per output, network control, loudspeaker processing, audio network capabilities, with the following characteristics required as shown on signal flows.

1. Key:
   a. ****x = minimum power rating listed at 8-ohm load, also capable of providing high impedance (70V) operation
   b. /* = number of channels per chassis
   c. N = network control capabilities

2. Acceptable Products:
   a. Crown DriveCore Install (DCI) Series, also includes the following:
a) \( A = \text{AVB} \)

b) \( B = \text{BLU-Link} \)

c) \( D = \text{Dante} \)

2.9 LOUDSPEAKERS – INSTALLED

A. General loudspeaker requirements:

1. Where visible, paint out or remove the manufacturer's logo on each loudspeaker.

2. Loudspeaker, and related mounting bracket(s) where appropriate, color shall be as selected by the Architect from the available color selection offered from each loudspeaker manufacturer.
   a. Loudspeakers in black ceilings shall be black. Refer to Architectural documents for clarification on locations of black ceilings, such as lockers.

3. For loudspeakers located outdoors or in an indoor humid environment (such as natatoria):
   a. Encapsulate all exposed loudspeaker wiring terminations in clear silicon type sealant or Star Brite Liquid Electrical Tape (800) 327-8583.

4. Utilize the most recent manufacturer-recommended DSP settings if available.

B. Loudspeaker C70-6", ceiling, six-inch loudspeaker, complete with enclosure, and integrated 70 volt transformer, switchable to 8 ohm:

1. Community D6; or

2. Martin Audio C6.8T; or

3. Tannoy CMS 601 DC; or

4. Approved equal.

C. Loudspeaker C70-8", ceiling, eight-inch loudspeaker, complete with enclosure, and integrated 70 volt transformer, switchable to 8 ohm:

1. Community D8; or

2. Martin Audio C8.1T; or

3. Tannoy CMS 801 DC; or

4. Approved equal.

D. Loudspeaker CS70-10", ceiling, ten-inch subwoofer, complete with enclosure, and integrated 70 volt transformer, switchable to 8 ohm:

1. Community D10SUB; or
2. Approved equal.

E. TV Soundbar – PSB/LCR: passive LCR sound bar:
   1. Klipsch RP-440D SB; or
   2. Approved equal.

F. TV Soundbar – ASB/LCR with Subwoofer kit: active LCR sound bar with subwoofer line level output:
   1. Bose Sound Touch 300 with:
      a. Bose Acoustimass 300; or
   2. Approved equal.

G. Loudspeaker FL/S8-12": powered twelve-inch subwoofer, line level input:
   1. JBL Studio SUB 260 P; or
   2. Approved equal.

H. Loudspeaker SM/WP70-6"-1010: weather rated surface mount loudspeaker, six-inch, 100x100 coverage pattern:
   1. Community R.15COAX; or
   2. Approved equal.

2.10 DISTRIBUTION AMPLIFIER

A. HDMI DA 1x4: 4K HDMI distribution amplifier with one input, minimum four outputs:
   1. Crestron HD-DA-4-4K-E; or
   2. Extron DA4 HD 4K; or
   3. TV One MG-DA-614; or
   4. Approved equal.

2.11 FIBER OPTIC SIGNAL TRANSPORT

A. Fiber optic audio and video products shall all be supplied from the same manufacturer through the signal chain (i.e. transmitter – switch – receiver).

B. HDMI over fiber pre-terminated cable: single input – single output, sends HDMI over hybrid copper and fiber cable. Transmits 1080p/60 or 1900 x 1200, stand alone, plenum rated, specified as a system with detachable ends, requires USB power per manufacturer’s recommendations, provide appropriate length for the required application, provide keystone connector at all wall plate terminations:
1. Celerity Technologies Fiber Optic HDMI with:
   a. Detachable keystone connector (at wall plate locations); or

2. Liberty DFO series; or

3. Approved equal.

2.12 VIDEO DISPLAY EQUIPMENT – PROJECTORS

A. Projector lens recommendations are based on conditions anticipated during the design phase. Site conditions may differ from the design documents. The Contractor shall be responsible for field verifying the screen size/location, projector mounting location, throw distance, lens shift capability and selection of the appropriate lens. Projectors shall be installed perpendicular to their objective screen or projection surface. Image alignment shall be via projector placement and lens shift only. Digital keystone correction is not acceptable. Digital manipulation of the image size is not an acceptable alternative to incorrect lens selection. Incorrect selection of the projector lens or incorrect installation of the projector in relation to the projection surface will not be an acceptable request for a change order.

B. All projectors are Owner furnished, Contractor installed.

2.13 FLAT PANEL DISPLAYS - GENERAL

A. All flat panel displays are Owner furnished, Contractor installed.

2.14 PROJECTOR MOUNTS & ACCESSORIES

A. Unless noted otherwise, provide the appropriate mount for each projector furnished. Mount color as selected by Architect. Match mount to the projector and the mounting surface.

B. Full assembly (projector, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural support shall be provided. No mounts shall fasten directly to the roof deck.

C. Shop drawing required. Refer to submittal requirements.

D. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.

E. Mount selection shall not be finalized before receiving make and model information for Owner-furnished projectors.

F. Projector Mount - Short Throw Wall: short throw projector mount, fully adjustable, sized for projector as required:
   1. Chief WM1 with RPAU; or
   2. Epson (per model recommendation); or
   3. Peerless PSTA-600; or
   4. Approved equal.
2.15 FLAT PANEL DISPLAY/TELEVISION MOUNTS

A. Unless noted otherwise, provide the appropriate mount for each display furnished. Mount color as selected by Architect. Match mount to the display and the mounting surface.

B. Full assembly (display, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural backing/support shall be provided. No mounts shall fasten directly to the roof deck. Refer to submittal requirements.

C. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.

D. All recessed or built-in displays/televisions require shop drawings showing the surrounding architecture to ensure proper fit and ventilation requirements.

E. Mount selection shall not be finalized before receiving make and model information for Owner-furnished displays.

F. Fixed Flat Panel Wall Mount: fixed mount, fully adjustable, lockable, sized for display as required:
   1. Chief FUSION *SM Series; or
   2. Peerless SF Series; or
   3. Premier Mounts P****F Series.

G. Articulating Flat Panel Wall Mount: articulating arm mount that pulls out, rotates, and tilts down, fully adjustable, lockable, sized for display as required:
   1. Chief TS***T Series; or
   2. Peerless SA Series; or
   3. Premier Mounts AM Series.

2.16 FRONT PROJECTION SCREENS – INSTALLED

A. All projection screens specified in this section shall have the following features or options included, unless noted otherwise for specific screens:
   1. Matte White screen surface, 1.0 gain
   2. Black backing on screen surface
   3. Extra drop as indicated on the drawings
      a. Screen fabric shall be fully deployed when at the specified height
   4. Aspect ratio as indicated on the drawings
   5. Motorized screen and concealment door, if applicable
6. Externally mounted electrical junction box / low voltage control interface

7. Low voltage wall switch, location as shown on plans

B. Projection screens are specified by series. Refer to drawings for exact screen size required per screen. Size listed as: (height in inches)-(width in inches). Deviance from basis of design size allowed +/- 2".

C. Coordinate final mounting position with appropriate parties. Ensure screen is mounted such that screen drop is not impeded by wall mounted devices, including any electrical devices or marker boards and trays. Screen drop shall not impact wall during deployment.

D. Ceiling mounted screens shown directly parallel to a wall surface without a given dimension are intended to be mounted such that the deployed screen surface is no more than 12" off the wall surface. If mounting conditions necessitate violation of this dimension, approval is required on an individual basis.

E. Projection Screen - ****-***-P/T/C: motorized tab-tensioned ceiling mounted projection screen. Image viewing area as listed on drawings (H" x W"):

1. Da-Lite Tensioned Advantage Deluxe Electrol or Tensioned Large Advantage Deluxe Electrol (large format) Series; or

2. Draper Ultimate Access/Series V or Ultimate Access XL/Series V (large format) Series; or

3. Stewart Filmscreen Cima Above Ceiling Series; or

4. Stewart Filmscreen Visionary or Visionary Grande (large format) Series; or

5. Approved equal.

F. Projection Screen – Photo Backdrop – P: motorized non-tensioned photo backdrop ceiling recessed projection screen. Canvas size as listed on the drawings (H" x W"), coordinate with Owner’s representative for digital copy of desired backdrop imagery:

1. Draper VCB Ultimate Access/Series E with:
   a. Custom screen-printed surface; or

2. Approved equal.

2.17 A/V CONTROL SYSTEM – EQUIPMENT

A. The AC power cord of the Control System Processor shall be connected to a rack-mount uninterruptible power supply (UPS). Refer to the AC Power section for specific models. The UPS shall be connected to an unswitched (unsequenced) AC power circuit.

B. Control system equipment shall be furnished from one manufacturer only. Program the system to provide acceptable operation by the Design Consultant and/or Owner’s Representative.

C. Select equipment that can be fully controlled by the control system furnished.
D. The drawings reflect a specific system manufacturer. If a different system manufacturer is furnished, shop drawings are required indicating proposed wiring configuration, control panel layouts, and equipment used. All of the features shown for the system on the drawings shall be maintained with the substitute system including coordination and costs related to back boxes, electrical, and other associated items.

E. All systems shall be accessible remotely via the Owner's LAN as directed by the Owner's Representative.

F. All control equipment necessary shall be furnished to provide a complete operating system. The required equipment includes but is not necessarily limited to the following components:

1. Touch Screen - W10"
   a. Extron TLP Pro 1022M

2. Control System - Processor
   a. Extron IPL Pro S6

2.18 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

A. Refer to Division 27 Section “Audio Video Systems” for general programming requirements with the following revisions and additions:

1. No additional requirements.

2.19 CABLES – FACTORY TERMINATED – PORTABLE

A. Factory terminated cable assemblies in this section are approved for portable use only.

B. Portable cable assembly quantities are identified in parenthesis and are required to be furnished in addition to those required for system installation. Portable cable lengths are a minimum not to exceed the maximum acceptable length identified in the cable descriptions below. Where specific lengths are cited adjacent to quantities, these lengths are to be taken as ideal lengths. If a pre-approved model series is not offered in the specific length cited, then the cable length closest to the cited length shall be provided unless the difference is greater than twenty percent. In this case, contact the Consultant for direction.

C. All cable assemblies must be factory tested and certified.

D. HDMI Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 1’-16’ (twelve 12’ portable required):

1. Comprehensive Pro AV/IT Series; or

2. Extron HDMI Ultra Series; or

3. Approved Equal.
2.20 CABLE ADAPTERS – PORTABLE

A. All unbalanced adapters requiring assembly shall be wired pin 2/tip "hot" and pin 3/ring tied to the shield. XLR adapters shall not have pin 1 connected to case ground.

B. Audio Adapter – TRS1/8 to 2RCA 6’, three conductor 1/8" male connector to dual RCA connectors with six foot cable (two required):
   1. HOSA CMR-206; or
   2. ProCo IPMB2R-5.

C. Audio Adapter – TRS1/8 to TRS1/8 6’, three conductor 1/8" male connector to three conductor 1/8" male connector with six foot cable (eight required):
   1. Hosa CMM Series; or
   2. Comprehensive MPS-MPS-*ST Series; or
   3. Approved equal.

2.21 PORTABLE ACCESSORIES

A. Work Light, clip-on work light (one required for each equipment rack, mobile cart turret, and mobile stage monitor case furnished):
   1. Lowell RL-1A; or
   2. Middle Atlantic model WL-60.

2.22 STANDBY EQUIPMENT

A. The following equipment shall be on-hand at the time of system final acceptance and system first-use for possible replacement of defective equipment or for field conditions noted. Maintain ownership of this standby equipment. However, if any item of this standby equipment is used to replace defective equipment, the installed item of standby equipment becomes Owner’s property. Assume ownership of the defective equipment:
   1. Backup software for programmable devices.
   2. Laptop computer for all programmable devices.

B. Allowances for overnight shipping shall be included and utilized if any component is required for Owner’s initial operation, first-use, or as directed by either the Owner’s Representative or the Design Consultant prior to Substantial Completion.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS

A. Refer to Division 27 Section “Audio Video Systems” for common requirements.
3.2 LABELING

A. Refer to Division 27 Section “Audio Video Systems” for labeling requirements.

END OF SECTION